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Origins of Labor Market Changes in the Transition to an Information Economy: Wage Structure, Employment, and Occupation Transformation in Taiwan after 1990

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Origins of Labor Market Changes in the Transition to an Information Economy: Wage Structure, Employment, and Occupation Transformation in Taiwan after 1990

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Labor market change in societies where an information economy is evolving, is a central area of concern for information society scholars today. While there has been considerable research conducted on cases of developed countries, research on labor market changes during a transition to an information economy outside of the advanced industrial economies is scarce. Thus, this dissertation proposes to examine the changes in wage, employment, and occupation structure that take place when an NIC, such as Taiwan, ushers in an information economy, and to explore the reasons behind these changes.

This dissertation combined the historical, policy, and statistical analyses and concluded that the transformation from labor intensive manufacturing to an information intensive economy, as arranged by the Taiwanese government due to its own political and

governing purposes, and also in the context of international political and economic circumstances, determined Taiwan's economic resource arrangement, which resulted in an increasingly unbalanced labor market in terms of wage distribution, unemployment, and occupation structure. This transformation changed and shaped the structure of the labor market to benefit workers more skilled with information, more professional, having higher level knowledge and a higher level of education, while an increasing amount of white-collar and service workers began earning comparatively low wages. At the same time the demand for blue-collar and lower skill workers severely declined. Moreover, the total labor demand of information manufacturing and information intensive service is much less than that of traditional labor intensive manufacturing, resulting in Taiwan's increasing unemployment problem. Among these processes, many different social, political, policy, and economic factors interacted and collectively determined this result. Among them, the role of the state in shaping Taiwan's information economy in general and the labor market situation in particular did matter considerably.

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Chapter 1: Introduction

INTRODUCTION

Labor market change and its impact on workers in societies where an information economy is evolving is a central concern for information society scholars today. A great deal of research focuses on emerging unbalanced labor market trends such as polarized occupation structure, unemployment, and increasing wage discrepancy. Though a number of changing labor market trends have been identified such as a decline of blue collar and managerial occupations, scholars are still far from having a consensus on exactly which labor market trends are brought on by transitions to information economies. Nor do they agree on the exact factors leading to these changes. A number of different possible causes are proposed, including information technology itself, knowledge/information expansion, industrial causes, and certain political economic factors such as government policies, market or monopoly power, and trade and globalization. The need to clarify and distinguish the specific reasons for labor market changes in an information economy is important because different determinants implicate different policy positions and solutions when facing unbalanced labor market outcomes. For example, scholars of informationalism, technological determinism, or postindustrial society may tend to agree more on improvement of individual's education and job training because they believe reduced disparity of skill and knowledge would be the cure for an unbalanced labor market in an information society. However, critical economic and political economic scholars tend to believe that it is political and economic structures that result in an unbalanced labor market, and hence they believe a government's macroeconomic policy should be the cornerstone for repairing skewed labor markets. All in all, it is important to research these issues not only because of their theoretical and philosophical contributions but also because these trends have real social and economic consequences with significant political and policy ramifications.

While there has been considerable research conducted on developed countries, research on labor market changes during a transition to an information economy outside of the advanced industrial economies is scarce. According to Castells (2004b), the development of information economies (or in his words "network societies") in developed countries was brought on by three accidental coincidences in the 1970s, linking three independent processes: the crisis and restructuring of industrialism and its two associated modes of production, capitalism and statism (deregulation, privatization, and market liberalization); the freedom-oriented, cultural social movements of the late 1960s and early 1970s; and the revolution in information and communication technologies (Castells, 2004b, pp. 3-45). But this throws little light on how information economies developed in newly industrialized countries. For example, as Wang (2003) points out, the ways that East Asian developing countries established their information economy were different from those of developed countries. First of all, unlike developed countries, which mainly offered incentives to stimulate high-tech R & D and information economy development, developing countries' governments built information economies directly by deciding on the preferred direction for industry and guiding the advancement of strategic industries (mainly information industries) by establishing favorable industry, tariff, and technology policies. Second, developed countries emphasized the invention and innovation of new avant-garde technologies, while developing countries stressed the acquisition of technological production knowledge obtained from developed countries. Third, the financial resources supporting information economy development in developed countries mainly stemmed from free capital markets, while in developing countries, the new economy was financed by public bank systems that complied with the government's industrial developmental plans. Given these differing historical, political, and economic factors in the development of an information economy, were the labor market changes under the growing information economy also different? Moreover, although some of the countries identified as "newly industrialized countries" (NICs) (or the above-mentioned

developing countries) such as Taiwan or South Korea have already reached a very similar or even higher level of economic informatization as that of developed countries, until now there have been very few, if any, empirical studies regarding their information economy development in general, and in particular their labor market situations during the transition to an information economy.

Seeking to help close these gaps in research and provide additional empirical evidence gathered through examinations of an NIC such as Taiwan, this dissertation offers two main contributions. First, it will become one of the first documents to comprehensively describe, record, and explain an NIC's (Taiwan's) labor market consequences in its transition to an information economy. Second, this dissertation will analyze the inter-play of various technological, economic and political forces in the processes of shaping an information economy and its labor market conditions. Specifically, this dissertation proposes to examine the changes in occupation, employment, and wage structure that take place when an NIC, such as Taiwan, ushers in an information economy, and to explore the reasons behind these changes. Thus, with a focus on labor market conditions, this research aims to reveal how the introduction of information, information technology (IT), and information industry into the economy, also known as informatization, along with other political and economic factors such as state policies, political elites, technical experts, enterprises, trade and globalization, labor market institutions, and international political economic causes, have shaped the trajectory of wages, employment, and occupation structure during Taiwan's transition to an information society.

The social and economic consequences of the transition to an information economy in newly industrialized countries have not been the subject of significant research. This is a significant issue because these labor market changes are critical to the overall social and economic structure of a society. A systematic study of labor market changes brought on by the evolving information economy in NICs would shed light on

one of the most important transformations underway in many countries and may further shed light on the social and economic future of these countries.

Taiwan was chosen as the focus of this research for two main reasons. In addition to providing a unique model as a developing state that has successfully transitioned to an information economy (similar to South Korea, as described above), Taiwan also plays a key role in the global information economy market. Taiwan is a small, rich, export-oriented island country with a population of around 22.9 million. Its industrial and economic structures evolved from agriculture in the 1940's to labor intensive light industry in the 1950's and 1960's, to capital intensive heavy industry in the 1970's, and then to today's information economy industry, which is based on information intensive high technology and strategic service industries. The whole process is very similar to the that of developed countries, yet the stage transformation from labor intensive to information intensive took Taiwan only about fifteen years to accomplish, whereas it took Japan twenty-five years and Great Britain over fifty years to complete the transition (Wade, 1990). Accordingly, the socio-economic consequences of this condensed process of informatizing the economy might be much more dramatic and acute than those experienced by developed countries[1]. In addition, owing to the extreme limitation of natural resources and its small domestic market, Taiwan has consistently relied strongly on global trade, especially on its own exports, to seek economic growth. It first started to develop export-orientated labor-intensive manufacturing such as apparel and miscellaneous manufacturing in the 1960's and became known as the world's production factory for this type of labor intensive manufacturing, along with South Korea in the 1960's and 1970's, continuing until the 1980's. Thereafter, faced with the rising cost of labor and land and increasing competition from other developing countries with cheaper labor pools, Taiwan was forced to make some major adjustments to survive in the world

[1] Similar situations can also be observed in South Korea and China.

trading market. It then discarded and moved out of the labor-intensive manufacturing and upgraded its industrial production capabilities to pursue more high-technique and knowledge intensive industries. It took advantage of its solid experience in manufacturing and the well-educated working population in Taiwan to promote policies favoring the growth of information/high-tech industries[2] and encourage greater adoption of IT and knowledge in production processes, aiming to finally and successfully accomplish Taiwan's critical transition to a new economy, the information economy, in the 1990's (Liang & Wang, 2002; Lin, 2004a; Ko, 2006). This transformation from a labor-intensive to an information-intensive economy (including both manufacturing and service industries such as information technology, microelectronic equipment, and finance; see Footnote 3) started in the 1980's and was completed in the early 1990's (Chu, 2003b). Since then, Taiwan has been consistently ranked among the top five in the world in IT production and has been one of the leading players worldwide in information and communication technology (ICT) penetration (T. J. Chen & Lee, 2004b; Mathews, 1996; Riedel, 1992). Moreover, the percentage of export of knowledge-intensive manufacturing compared with total manufacturing export reached 70.60% and 71.17% in 2003 and 2004 respectively (S. W. Lin & Lin, 2005). The contributions of Taiwan's information-centered services and manufacturing industries were estimated to have jointly produced at least 45% in 2006, the largest portion of its total GDP,[3] which again underscored the

[2] For example, in 1991, the Taiwanese government started to institute its most influential information-economy policy, "Enforcement Rules of the Statute of Upgrading Industries," in order to sustain Taiwan's information economy and to enhance Taiwan's information industries' competitive advantages in the world market.

[3] According to OECD (OECD, 1996; 2001), knowledge/information intensive industries include mainly two sections—information intensive manufacturing and information intensive service. Information-centered manufacturing includes high-tech industries such as aerospace and production of computer and data processing equipment, automation equipment, pharmaceuticals, telecommunications equipment, semiconductors, and scientific instruments; and middle-tech industries such as production of automobiles, electrical equipment, specialty chemicals, machinery and other transport equipment. Information-centered service industries include finance, insurance, real estate, commercial services (including computer software production, computer and data processing, research and development, and engineering services), professional, scientific and technical services, social and personal services, education, medical services, transport, storage, and communication. The final result is computed by the Council for Economic Planning and Development, R.O.C. (Taiwan Economic Statistics, 2007).

completion of Taiwan's conversion to an information economy. To accurately characterize the economic and industrial shift, the Taiwanese government named the 1990's as the period of high-tech (mainly information technology) and the 2000's as the period of the knowledge economy.

The fact that Taiwan has witnessed a successful and quick economic transition to occupy a crucial position in the world's information economy and that such a transition has been well documented suggests that Taiwan indeed makes an excellent case study for scholars seeking to better understand the information economy and its possible impact on the labor market. Such a study will prove all the more valuable in the sense that there have so far been few relevant empirical studies of NICs transitioning to an information economy. Specifically, this dissertation will attempt to deepen our understanding of the forces that shape such transitions and the social and economic consequences of the transition. By focusing on labor market changes, this dissertation will provide empirical evidence to contribute to one of the most contentious issues in the scholarship of the information economy – how such transitions change the occupational, employment and income patterns in societies. Therefore, the research goals of this dissertation include: 1) exploring the historical, political, economic and technological forces that have shaped the development of Taiwan's information economy and labor market changes; 2) understanding the changing trends of occupation structure, employment, as well as income and wage disparity in the country's evolving information economy; and 3) identifying and analyzing the sources of these labor market changes.

This dissertation will employ multiple research methods. It will apply historical, policy, and political economic analyses to study Taiwan's information economy transformation and the roles of government, policies, political elites, enterprises, experts, foreign businesses, foreign governments, as well as other domestic social groups in the information economy development and labor market changes. Such analyses will help reveal how informatization, state policies, global competition, pursuit of national

economic growth, industrial changes, labor market institutions, and other factors might either reinforce or challenge each other and collectively affect labor market structure in Taiwan's information economy age. The dissertation will document the transformation of Taiwan to an information economy and through statistical analysis identify the changes that have taken place in the country's occupational structure, employment levels and income distribution during the course of this transition.

ORGANIZATION OF THE DISSERTATION

This dissertation is organized as follows:

Chapter Two will review the concepts of informatization, information society and economy and will explore the development and extent of Taiwan's information economy.

Chapter Three will chart Taiwan's economic/industrial history, the developmental history of Taiwan's information economy, and the policies of the information economy. Finally, it will offer a historical perspective on how factors such as the state and policies, political elites, technological experts, domestic enterprises, foreign capital and governments, domestic social groups, trade and globalization, and industrial transformation have interacted and worked together in shaping Taiwan's information economy.

Chapter Four will use statistical data and statistical analysis to examine occupational transformation and to explore the sources of these changes that occurred in Taiwan as it evolved into an information economy.

Using statistical data and statistical analysis, Chapter Five will explore the changing employment trends and track the sources of the labor market changes that arose in Taiwan as an information economy evolved.

Chapter Six will chart changing wage structure trends that developed during Taiwan's evolution into an information economy. This will be accomplished by using

statistical data and statistical analysis such as the Theil's statistics. Using the Theil's statistics, we can also find the sources of inequality and determine if they are related to information economy.

Chapter Seven, the last chapter, will present the main conclusions of the research. It will summarize the reasons identified for the labor market changes in the age of information economy. In addition, the corresponding information economy theories will be reviewed and critiqued accordingly, and possible suggestions regarding labor market policies for countries having an information economy will also be provided.

Chapter 2: Information Economy: The Case of Taiwan

This chapter reviews relevant literature that will first define and clarify the concepts of information technology, informatization, as well as information economy/information society and then will discuss various measures and indicators of information society and economy. In the last section, the chapter will chart the extent of Taiwan's informatization.

INFORMATION TECHNOLOGY AND INFORMATIZATION

The main idea underlying the notion of an information economy is that, due to the information technology revolution and the extensive adoption of IT, the production, handling, distribution, monitoring, possessing, use, and application of information and information technologies have become the most prominent feature of an economy. In other words, information and IT have impacted most of the major economic activities in some societies (1993; Hearn, 2004; Porat, 1977).

Information technology refers to any technology that handles information in an electronic form which distributes, transforms, or processes information (Martin, 1997). According to Zuboff (1988), information technology (IT) is a label or term that reflects the convergence of several streams of technical developments, including microelectronics, computer science, telecommunications, software engineering, storage devices, and any system analysis. It is a technology that dramatically increases the ability to record, store, analyze, and transmit information in ways that permit flexibility, accuracy, and complexity. Moreover, information technology has a unique capability to restructure operations that depend upon information for the purposes of transaction, record keeping, analysis, controls, or communication. The World Bank (2002) and the OECD (2002) use the term information technology to refer to the creation, storage, and processing of data, including hardware (computer network, servers, storage devices, and desktop computers), system software (operating systems, middleware, programming

languages), and software and applications. For purposes of the current research, "information technology" mainly refers to those digital devices and services derived from computers, the Internet, and telecommunications.

Information technologies are unique, especially in contrast to previous technologies. Lievrouw and Livingstone (Lievrouw & Livingstone, 2002) summarize that the uniqueness of information and communication technologies (ICTs) includes their two-way capabilities of computing and telecommunications as well as the demassified, time-shifting and human-computer features. More specifically, Martin (1997) elaborates three fundamental differences between earlier technologies such as books, filing cabinets, pens and paper, and more recent information technologies including computers, LANs/WANs, teleconferencing and on-line databases. First, the new technologies deal with information in an electronic form. Second, many of the new technologies are networkable, meaning they can be hooked together for the purpose of information sharing. Last but not least, they are completely programmable or semi-programmable, meaning these new technologies are capable of performing information handling within the limits of coded instructions. With a main emphasis on the work place, Zuboff (1988) characterizes information technologies as the technologies used to reproduce, extend, and improve on the processes of substituting machines for human agency, and the devices that automate by translating information into action and register data about those automated activities, thus generating new streams of data.

While information technology refers to the technologies themselves, informatization is a more dynamic term, referring to the process and the result of applying information technology to various social processes such as automation of production and office computerization. In this dissertation, I will mainly focus on informatization in the economic sphere and with respect to the macro and organizational levels. On the macro level, informatization refers to the process through which the main productive activity of the economy turns from material production to information

production[4] with the effective introduction of information technology. It has been suggested that informatization is a process of change that features: (1) the use of the information technologies to such an extent that they become the dominant forces in commanding economic, political, social, and cultural development; and (2) unprecedented growth in the speed, quality, and popularity of information production and distribution (G. Wang, 1994).

More specifically, Dizard (1985) identifies a general development pattern of informatization. In this pattern, there are three progressive stages of informatization and information economy: (1) the development of a primary information sector; (2) the increasing dependency upon and adaptation to information technologies, and (3) the mass consumerization of high-technology information services. All three stages are well developed in the advanced industrialized countries, and NICs are in various stages of this trajectory as well. Worldwide, industry is building the high-technology infrastructure that will form the basis for the information economy. Industries and organizations, both private and public, who are the primary users of the new information technology networks, are already very dependent on information technology, and such dependence is increasing exponentially. The third stage is the mass consumerization of information technologies and information services. Advanced information and communications resources, earlier limited largely in use by big businesses and big governments, are now used extensively by individuals and small organizations, providing a wide range of computer-based information resources.

Further, if we investigate the idea of informatization on the organizational level, there are four dimensions for business and industry informatization: first, informatization of production such as production automation or use of artificial intelligence; second, informatization of production factors (such as the use of techniques, skills, or

[4] Even though material production still plays a crucial part in this new economy, it is now also characterized as containing more knowledge/technique in the production processes.

knowledge), often achieved by promoting R&D and used to replace labor and capital as the main production factor to enhance productivity; third, informatization of management such as improving managing efficiency through harnessing the information technology to control or monitor production processes or workers; lastly, informatization of organization such as shortening communicating time and distance by the information technology in organizations, which often leads to the transformation of an organization structure such as flattening organizations (Ma, 2003).

In this dissertation, informatization, refers to, from the macro-economic perspective, the transition to an economic system which focuses mainly on the production, application, and consumption of information/knowledge, IT and information/knowledge services; from the organization or production perspective, this dissertation uses the term informatization to refer to the informatization of production processes and of production factors.

INFORMATION SOCIETY AND ECONOMY

An information society is a society in which the production, accumulation, extension, possession, distribution, use, and consumption of knowledge/information and information technologies are the driving forces for social change [5], and knowledge/information is the most significant factor, when substituting for capital or labor for most economic, political, and cultural activities (OECD, 1996; EC, 2000; APEC, 2000) without being subject to diminishing returns. Such a society is characterized by the growth of an information sector and information application in the economy, whereby wealth is created through the economic exploitation of understanding and knowledge, which is the center of economic production (Dordick & Wang, 1993; Hearn, 2004; Porat, 1977). Thus, information economy, or its synonyms "knowledge

[5] The observed changes cover many aspects of society, including changes in economy, in the work place, in politics, in culture, in education, in social networks, as well as in family and daily life.

economy" and "new economy," is not restricted only to high technology or information technology industries but also spreads out to almost all industrial sectors (Wei, 2002).

Information/knowledge economy can be traced at the earliest to economist Adam Smith (1776),who pointed out the big contribution of technique progress (knowledge accumulation) on economic growth in his *"An Inquiry into the Nature and Causes of the Wealth of Nations."* Alfred Marshall (1890) further explained that the application and progress of knowledge always lead to the invention and adoption of new production means and new production machines, which enhance the production efficiency of labor and capital; thus, knowledge is the most powerful engine of economic and production growth. As to the 20th century economists such as J. A. Schumpeter (1912) and Simon Kuznets (1966), both put the importance of knowledge innovation on technique progress, production enhancement, and economic growth.

Bell (1980) introduced the idea of post-industrial society, which he claimed as a synonym of information society. Through this idea, Bell considered information and information technologies' revolutionary influence on the whole society system. According to him, in an information society/economy, the source of productivity and economic growth lies in the generation of knowledge, extended to all realms of economic activities through information processing. The new economy increases the importance of occupations with a high information and knowledge content in their activities. Likewise, the codification of theoretical knowledge for innovation in technology also plays a crucial role. Finally, the creation of a new intellectual technology (such as the technology of artificial intelligence) is the key tool of system analysis and decision theory.

Schement (1990) believed that we were entering an information economy age, which could be observed by following the course of developments in the information economy, information technology, and information work. Interactions among these three events have led to a profound socio-economic shift. First, information-oriented activities continue to grow as the primary sector of the economy, with information becoming a

major commodity of exchange. Second, computers and other information technologies are shaping the production and distribution of information as well as reframing the context of everyday life. Third, information work has become the primary form of employment and is necessary to produce new devices and transmit the primary commodities. It is from this convergence of economic forces that an information society begins to emerge.

Observing and comparing different cases of the information economy in different countries, Hearn (2004) found three common characteristics in most of the various kinds of formulations of an information economy: increasing numbers and proportions of workers in organizations specializing in information production, handling, distribution, monitoring, and use; increasing numbers of organizations specializing in information production, handling, distribution, monitoring, and use; and finally, people and organizations increasingly affected by information production, handling, distribution, monitoring, and use in more spheres of life.

More specifically, Masuda (1990) clarified the idea of an information economy by comparing the industrial society with the information society. He concluded that an information economy is different in five aspects: (1) The production center: In the industrial society, the modern factory, consisting of machines and equipment, was the production center for goods. In the information society, the information utility (a computer-based infrastructure), consisting of information networks and data banks, will replace the factory and become the production and distribution center. (2) The market: In the industrial society, the increase in consumption purchasing power was the main factor in the expansion of the market. In the information society, the knowledge frontier will become the potential market, and the increase in the possibilities of problem solving and the development of opportunities in a society that is constantly and dynamically developing will be the primary factor behind the expansion of the information market. (3) The industry: In the industrial society, the leading industries in economic development

were machinery and chemicals, and the total structure comprised primary, secondary, and tertiary industries. In the information society, the leading industries will be the intellectual or knowledge industries. (4) Economic structure: The economic structure of the industrial society was characterized by: (a) a sales-oriented commodity economy, (b) specialization of production utilizing, (c) divisions of labor, and (d) a complete division of production and consumption between enterprise and household. In the information society, information, the axis of socioeconomic development, will be produced by the information utility; self-production of information by users will increase an information will accumulate. This accumulated information will expand through synergetic production and shared utilization, and the economy will change structurally from an exchange economy to a synergetic economy. (5)The most advanced stage: In the industrial society, it was a highly developed mass-consumption stage, centering on durable goods. In the information society, it will be a highly developed mass-knowledge creation society, in which computerization will make it possible for each person to create knowledge and to go on to self-fulfillment.

Overall, in this dissertation, the information-intensive industries, information economy, and relevant activities refer to four perspectives: first, application of information and information technologies in business and production processes such as production technique improvement or digitalized management, which will lower production cost and improve production efficiency; second, selling or using information directly as commodities such as database services or education; third, production of information technologies such as computer or telecommunication technology industries; and fourth, making profits by circulating or processing information such as portal site services or data handling.

MEASURING INFORMATION SOCIETY AND ECONOMY

There has been much debate and discussion about the many standards and indices used to measure an information society and economy since the two terms were first proposed. Different indices focus on different aspects of informatization. For example, the New Economy Index[6] from the Progressive Policy Institute primarily stresses the economic conversions in information society, with its underlying indicators covering the amount of knowledge jobs, economic dynamism, the digital economy, innovation capacity, economic development strategies, and the magnitude of globalization. In comparison, another representative index, the International Telecommunication Union's (ITU) "Digital Access Index[7]," underscores access to information and communication technologies such as infrastructure, affordability, quality, usage, and knowledge.

If we elect to adopt a more comprehensive approach by combining these indices together[8], we can group their sub-indicators into the following categories:

Information infrastructure (or availability)

Including indicators such as telephone mainlines per 100 (inhabitants), cell phone per 100, Internet servers per 100, Internet/web sites per 1000, PCs per 100, broadband per 100, student –to-computer ratio, government online services, cable per household, etc.

Readiness (or skill and knowledge)

Including adult literacy rate, tertiary or college enrollment rate, ability to use computers, etc.

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[6] An index used to measure the impact of informatization on industrial structure, market, and economy. Please refer to http://www.neweconomyindex.org/

[7] Please refer to http://www.itu.int/newsroom/press_releases/2003/30.html

[8] The indices applied in this research contain World Economic Forum's the "Networked Readiness Index," ITU's the "Digital Access Index," the Progress Policy Institute's "New Economy Index," the UNESCO's "Monitoring the Digital Divide," McConell International's "e-Readiness," the Economist's "e-Business Readiness Index," The Human Development Report's "Technology Achievement Index," IDC's "Information Society Index," the Japanese Information Study Group's information flow measurement, and Vere (2005).

Affordability

Including Internet access price, cost of local phone calls per 3 minutes (both peak and off-peak hours), cost of international phone calls per 3 minutes (both peak and off-peak hours), cell phone monthly subscription charges, cost of cell phone calls per 3 minutes (both peak and off-peak hours), Internet service provider charges, etc.

Quality

Mainly including Internet upload and download speeds and access, waiting time for telephone lines, telephone faults per 100 main lines, and the overall telecommunication quality.

Usage (reach)

The measurement of usage in some indices sometimes has indicators similar to the measurement of the infrastructure. This index might incorporate indicators such as personal computers, ISDN subscribers, cable television subscribers, cell phone subscribers, total telephone lines, average time spent per month on the Internet (hours), Internet use (percentage of the population who have used the Internet at least once in the three months prior to the survey), purchase of products or services online (percentage of the population), music (MP3) downloads (as a percentage of the population), online banking with a financial institution (percentage of the population), etc.

Information flow

Incoming and outgoing telephone traffic, domestic long distance telephone traffic, domestic local telephone traffic, information supply (the amount of information transmitted by various sources through media), information consumption (the amount of information consumed by audience), etc.

Information economy measurement

The most common measuring indicators for information economy include the percentage of information-intensive industries' contribution to the total GDP and the

percentage of information industries' employment in the economy. Other indicators also include the numbers of computers installed in businesses, the number of utility patents, the percentage of expenditure on R&D in the total GDP, the E-commerce revenues (as a percentage of the GDP), the percentage of businesses that provide information on goods and services online, the percentage of businesses that allow customers to order goods and services online, the percentage of businesses that allow customers to make payments online, the percentage of employees using the Internet at least once a month, the percentage of businesses that use online banking or investment services, the density of businesses' automation equipment, the density of businesses' informatization equipment, the export and import of ICT equipment, telecommunication service revenues, the amount of commercial Internet domain names, and capital-labor ratio (or labor productivity index), etc.

MEASURE AND INDICATORS FOR INFORMATIZATION AND INFORMATION ECONOMY IN THIS DISSERTATION

Drawing from the literature review, the concept of informatization can be divided into three perspectives. From the macro-economic perspective, informatization refers to the transition to an economic system that focuses mainly on the production of information/knowledge, IT, and information/knowledge services; from the production or business/organization perspective, informatization refers to informatization of production processes and production factors; and from a general perspective, informatization refers to the increasing usage and application of information/knowledge, IT, and telecommunication services in our society. This dissertation will mainly adopt these three perspectives as the three main dimensions of the concept of informatization. For the macro-economic perspective regarding informatization, the two principal and most commonly used indicators of informatization are the percentage of information-intensive industries' contribution to the total GDP and the percentage of information industries' employment in the economy. Production or an organization/business perspective on

informatization incorporates two aspects: informatization of production and informatization of production factors. For informatization of production, the only indicator that is supported by statistical surveys and data in Taiwan [9] is the density of businesses' automation equipment. With regard to informatization of production factors, according to Ma (2003), the most direct indicator, and the one supported by the greatest amount of data, is the measure of expenditure on R & D to the total GDP. With respect to the infrastructure and usage of information technology, this refers to the digital devices and services derived from computers, the Internet, and telecommunications. Thus, this dissertation will mainly use such relevant indicators as personal computers per 100 inhabitants, Internet users per 100 inhabitants, main telephone lines per 100 inhabitants, and mobile cellular telephone subscribers per 100 inhabitants.

TAIWAN'S INFORMATIZATION

Some scholars assert that over the past two decades, Newly Industrialized Countries such as Taiwan have transformed from an industrial economy to an information/knowledge economy (T. J. Chen & Lee, 2004b; Y. X. Chen, 2002; Katz, 1988; Y. S. Ko, 2006). As we can see from Taiwan's history, the priority of its economy shifted from agriculture to labor-intensive manufacturing in the 50s and 60s, to heavy chemical industry in the 70s, and then to an information economy started in the 80s and completed in the early 90s (Chu, 2003b; Ho & Lo, 2002; Y. S. Ko, 2006; C. F. Lin, 2004b; H. M. Tsai, 1999). Most scholars who study Taiwan's economy argue that the transformation to an information economy has become necessary for Taiwan under the mounting pressure of a continual loss of competitiveness in labor-intensive industries because of increasing production costs, especially due to the upsurge in wages and land prices (T. J. Chen & Lee, 2004b). Indeed, its annual growth fell to 6.42% in the 1990s; in

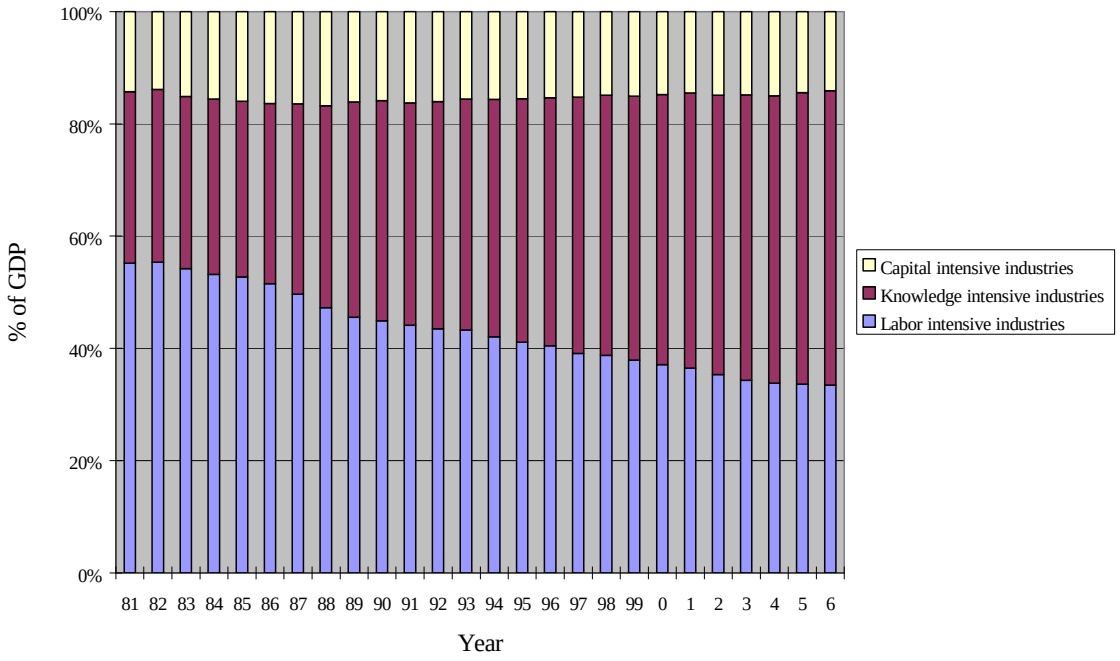
[9] Relevant indicators such as computer and Internet use rates in businesses are lacking.

2001 Taiwan even experienced some negative growth, which sharply contrasted with the previously phenomenal average growth of 9.15% between 1960 and 1990. The decline in the economy and industrial competitive capacity created a strong case for a paradigm shift from a labor-intensive economy to an information-intensive economy in Taiwan, as an information and knowledge economy is believed to be much less vulnerable to the increasing cost of material resources and land and will face less competition from other developing countries (T. J. Chen & Lee, 2004b).

To understand Taiwan's economic evolution to an information economy, we can observe the data comparing the sectoral percentage to the total GDP over time. Table 1 and Figure 1 provide these data. As we can see, there has been a consistent increase in the role of information-intensive industries in the total GDP; the percentage of the information-intensive industry to the total GDP has grown from 1981 when it represented 30.59% to 2006, when information-intensive industries composed 52.45% of the total. It surpassed labor-intensive industries in 1994 (42.27% V.S. 42.10%). In contrast, the percentage of labor-intensive industries dropped from 55.15% to 33.42%, and capital-intensive industries remained at almost the same level, dropping only slightly from 14.25% to 14.12% between 1981 and 2006. The industrial and economic transition to information intensive industries was generally acknowledged to have been initiated in the middle of the 1980s but not completed until the 1990s (Chu, 2003d); from Table 1 and Figure 1, we can also see these relative changes clearly.

Table 1. Sectoral percentage of the total GDP

Year / Sectoral %	1981	1984	1987	1990	1993	1996	1999	2002	2005	2006
Information-Intensive	30.59	31.28	33.86	39.20	41.20	44.16	47.02	49.76	51.9	52.45
Labor-Intensive	55.15	53.17	49.67	45.56	43.25	40.48	37.87	35.34	33.6	33.42
Capital-Intensive	14.25	15.55	16.47	16.10	15.55	15.36	15.11	14.90	14.5	14.12

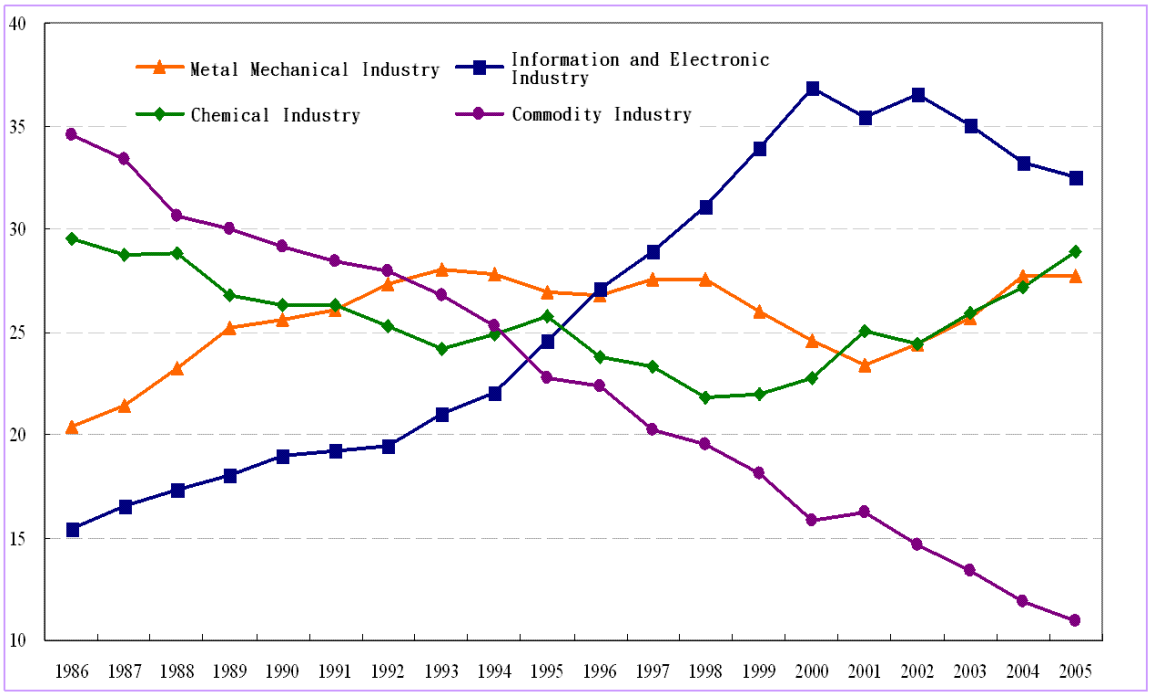


Source: W. C. Wang (2008) [10]

[10] This calculation was based on OECD's (OECD, 1996; 2001) definition of knowledge/information intensive industries. They include mainly two sections: information intensive manufacturing and information intensive services. Information-centered manufacturing includes high-tech industries such as aerospace, computer and data processing equipment, automation equipment, pharmaceuticals, telecommunication, semiconductors, scientific instruments, and mid-tech industries such as automobiles, electrical equipment, specialty chemicals, machinery and other transport equipment. The information-centered service industries include finance, insurance, real estate, commercial services (including computer software, computer and data processing, research and development, engineering services), professional, scientific and technical services, social and personal services, education, medical services, transport, storage, and communication.

Figure 1. Sectoral percentage of the total GDP

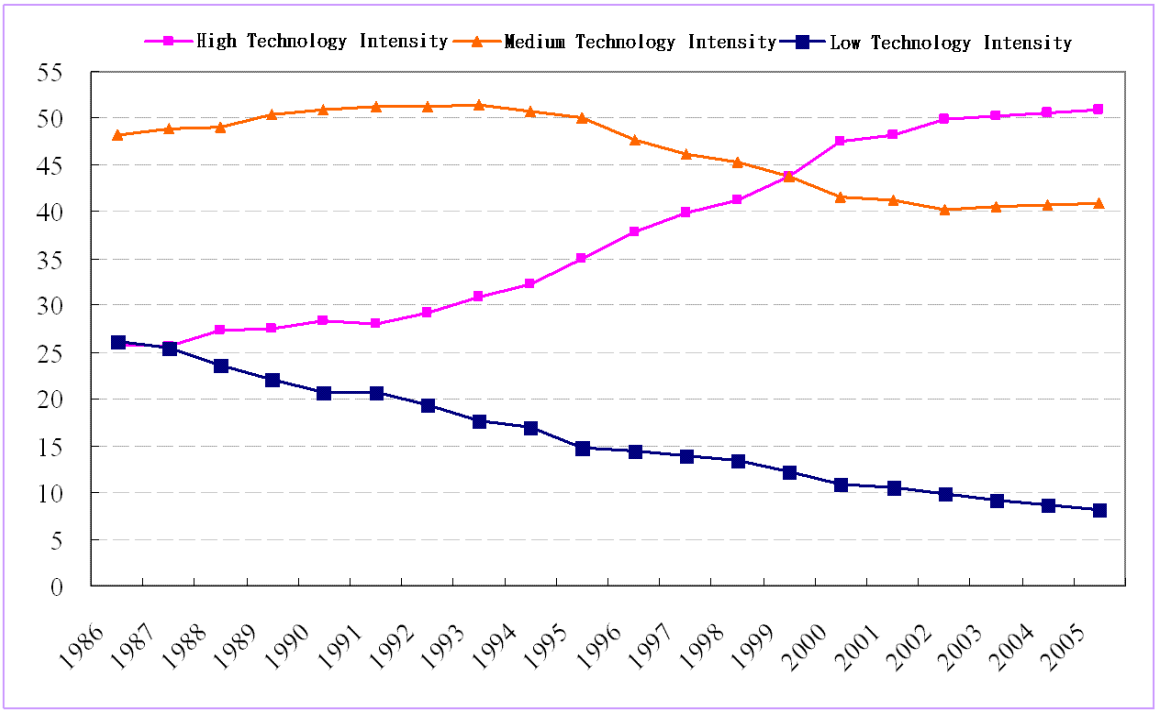
Figure 2 shows the growing importance of the information and electronics industry in manufacturing. Before 1995, the production value of the information and electronics industry was the lowest among the four main manufacturing industries. However, after 1995, it first surpassed the commodity industry, then in 1996, surpassed the chemical industry, and in 1997, surpassed the metal mechanical industry, becoming the primary industry of the four main manufacturing sectors. As for the labor intensive commodity industry, it experienced a dramatically declining trend, dropping from 35% in 1986 to around 10% in 2005. The chemical industry is closely related to the integrated circuit (IC) industry and had clear growth after 2000 when more and more mature electronic industries immigrated to China for lower production costs, leaving IC as playing the main role in Taiwan's manufacturing production.



Source: Department of Statistics, Ministry of Economic Affairs

Figure 2. Percentage changes in the four main sectors of manufacturing

Figure 3 presents the changing importance of industries at different technical levels. As seen in this figure, the production value percentage of the low technology/ technique industries among the three technical levels showed a continued declining trend, from 25% in 1986 to less than 10% in 2005. Medium-level technology/technique industries also show a declining rate from 51% in 1994 to 41% in 2005. In contrast to these two industries, the high technology/technique intensive industry shows amazing growth. It grew from 25% in 1986 to 44% around 1999, for the first time surpassing the percentage held by medium-technology industries in the same year, and then began to comprise more than 50% of total industries in the year 2000.



Source: Department of Statistics, Ministry of Economic Affairs

Figure 3. Percentage changes of different technology intensive industries

These data all show us that Taiwan's economic production model underwent an obvious change from lower-skilled, less knowledge-based, lower technology, labor

intensive manufacturing to information-intensive and high-technology economic production.

To what extent has Taiwan's informatization reached in recent years? According to the ITU database (2007), the percentage of homes with a personal computer was 66% in 2005, with Internet service was 65% in 2005 (among them, broadband accounted for 78%), with a telephone was 98% (in 2003), and with a television was 94% (in 2003). There were 102 mobile telephone subscribers per 100 inhabitants in 2006. As for business informatization, according to the Department of Industrial Technology, R.O.C. (2006), the production automation rate in Taiwan was 75% in 2006, and the use of computers in all business sectors was 93.50% in 2004. The average percentage of Internet use in all companies was 86.10% in 2005, and in 2002 the business website construction rate was 35.7% and was 76.9% for big companies. As for introducing electronic systems into businesses, in big companies, the introduction rate was 100% in 2004, in medium companies the rate was 38.9%, and in small companies it was 18.7%.

Some worldwide indices of information economies can also help indicate Taiwan's level of informatization. According to the 2008 Information Technology Industry Competitiveness Index of the Economist Intelligence Unit (EIU) (2008), Taiwan's overall scores ranked second in the world for IT competitiveness just after the USA. Its R & D environment was ranked first, human capital ranked seventh, and IT infrastructure ranked 20th. Furthermore in 2005, Taiwan's electronic industry ranking was ninth, its electronic government ranking was fourth, and its information society ranking was seventh (Science and Technology Advisory Group of Executive Yuan, 2008). Another important indicator, the World Economic Forum's (2007) Networked Readiness Index 2006-2007, ranked Taiwan 13th in the world, one place behind Hong Kong but one place before Japan, and three places before Germany. Similarly, on the International Telecommunication Union's (ITU) "Digital Opportunity Index" (DOI) in 2005, Taiwan ranked sixth in the world; and in ITU's 2004 "Digital Access Index" (DAI), Taiwan

ranked ninth ("Telecommunications statistics," 2007). According to the ITU data, Taiwan scored high across the board on all measures of the deployment of ICTs. Taiwan's global rankings for ICT service penetration rate in 2003 were as follows: mobile telephony, second; Internet access, fifth; broadband access, fifth; and local telephony, 17th ("Telecommunications statistics," 2007). Taiwan placed in the top two or three NICs for the extent of informatization and compared very favorably to even very high-income countries. As measured by the contribution of information intensive industries to the total GDP, by the penetration of ICTs, and by information economy indices, Taiwan has clearly made the transition to an information economy. The penetration of ICTs and information is broad across the economy and deep within most industries and corporations.

In fact, Taiwan consistently ranks among the top five countries in IT-related product or technique production. For instance, in 2005, Taiwan ranked number two in the world in IT hardware production. It claims the largest market share in the world for laptop (86.2%, 2006), motherboard (99.0%), liquid crystal display (LCD) (76.5%), and monitor (52.0%) production. Other competitive products also include desktop computers (30.2%), servers (34.8%), CD-ROM drives (33.1%), and digital cameras (42.3%). Some of other leading products without sufficient statistic data include semiconductors, IC (integrated circuit) designs and wafers (Ministry of Economic Affairs, 2008).

As for the informatization of labor, according to a 2005 survey of the Directorate-General of Budget, Accounting and Statistics, R.O.C. (the DGBAS) (2005), the average percentage of employees' use of computers at work in Taiwan was 75.6%. The highest use rate was for professional workers (93.60%), and the second and third highest were for clerks (91.40%) and managers (83.8%); among service workers, 54.8% used computers. Workers in agriculture, forestry, and fishing had the lowest rate (25.10%); and the second lowest ranking was held by elementary workers (labor workers) and machine operators (37.40% and 37.60%, respectively). If we analyze these data by industry, public

administration was the highest, with a usage percentage of 95.80%, and finance and insurance was second with a rate of 95.20%. The lowest rate was in the field of agriculture, forestry, and fishing, at 32.90%; and the field of food and lodging services had the second lowest rate, 41.40%.

The rates for Internet use at work were quite similar to those for computer use. The average rate of use for all workers was 59.50%. Professional workers and clerks remained the two groups with the highest rate of use (79.10% and 73.90%, respectively). Agriculture, forestry, and fishing workers, machine operators, and elementary workers (labor workers) were again the groups with the lowest rate of use (14.00%, 15.30%, and 21.10%, respectively). Analyzing the data by industry, we see that the three groups of public administration, finance and insurance, and education are again the sectors with the greatest use of Internet at work, with Internet use rates of 83.20%, 81.20%, and 79.60%, respectively. Additionally, the groups of agriculture, forestry and fishing along with the accommodation and food service group were again the sectors with the lowest use rates, which were 23.10% and 26.20%, respectively.

The completion of Taiwan's transition to an information economy is also obvious from the impact of information technologies and informatization on its economy in areas such as improving efficiency, inducing innovation, enhancing labor productivity, expanding new markets, shortening products' production and circulation processes, and accelerating and expanding the flow of capital and ideas. Furthermore, information technologies are by themselves a crucial product market, contributing remarkably to the whole world's GDP growth (Castells, 1996a; Harvey, 2005; McKenzie, 2003). As some researchers have pointed out (*2006 Electronic Business White Paper in Taiwan*, 2006; Y. X. Chen, 2002), IT has not only contributed greatly to many aspects of Taiwan's economic development (such as integrating domestic companies' resources and inducing their cooperation, breaking geographic limitations and thereby enabling domestic companies to gain transnational cooperation, and helping domestic companies to design

products of internationally competitive capacity), but it has also become the most profitable industry in Taiwan's economic development since 1990.

Consequently, macro level data suggest that it is appropriate to classify Taiwan's economy as an information economy, based on sectoral level comparisons, on company application of technology (according to worldwide indices) on its global market share of high technology products and services, and on the informatization of labor.

Chapter 3: History, Policy, Development, and Social Forces of Taiwan's Information Economy

By applying policy, historical, and also political economic analysis, this chapter will mainly discuss and outline Taiwan's economic and industrial history, the development of its information economy, information economy policy, and also the different social forces that are in the process of influencing the growth of Taiwan's information economy.

A BRIEF HISTORY OF TAIWAN'S ECONOMIC AND INDUSTRIAL DEVELOPMENT

Taiwan's contemporary economic development can be roughly divided into seven different phases from a historical perspective (Liang & Wang, 2002; C. F. Lin, 2004a). The period from 1945 to 1952 was the recovery period from World War II and from the civil war between the Kuomintang Party and the Chinese Communist Party. This period of time was characterized by high inflation and economic inequality. In response, the Kuomintang government pushed currency and land reform in order to stimulate agricultural production and also to redistribute income out of a concern for social stability (Amsden, 1985). The Kuomintang also worked to develop the electronic, fertilizer, and textile industries to meet the needs of the domestic market, with agriculture playing a leading role in economic development at that time (Amsden, 1985). Economic inequality at this time was relatively high due to unstable economic conditions (Cornia, 2000).

From 1953 to 1960, economic aid from the U.S. due to the Korean War and the Cold War helped Taiwan build its economic and industrial foundation. During that time, the government used the exportation of fertilizers to funnel profits from agriculture into industries to promote industrial development. The central industries supported by the government were light industries mainly developed to meet various domestic needs such as textiles, food, electric appliances, and chemical products. It was during this period that Taiwan began to export textile products; nevertheless, agriculture remained a leading

player in Taiwan's exports and a major contributor to the GDP. Economic policies of this time included focusing on land reform, encouraging foreign investment, devaluating the new Taiwanese dollar, adopting a bi-exchange rate to control foreign exchange, limiting imports, and using high custom duties to protect domestic industries (R. L. Chen, 2006). Thanks to the rapid expansion of employment for both well-educated and low-skilled workers, economic inequality declined little by little.

The period from 1961 to 1972 was considered the golden age of economic development (the highest growth rate in Taiwan's history) and also the heyday of labor-intensive manufacturing in Taiwan, during which time the country completed its export-oriented industrialization and successfully emerged as one of the most important production sites (labor intensive products) for the American and Japanese markets (Ho & Lo, 2002; C. F. Lin, 2004b). This stage also marked an important turning point as Taiwan's economy changed its main focus from agriculture to manufacturing. Main industries in this stage were light industries such as textile, leather and fur, foodstuff and glass industries. In addition to the export of labor-intensive products, the government of Taiwan also began to help expand heavy and capital-intensive industries such as petroleum, chemicals, steel, automobiles, shipbuilding, and plastics manufacturing, in order to advance Taiwan's industry structure. The attraction of American and Japanese capital investments to Taiwan was one of the principal economic strategies at this time. Thanks to the mass employment offered by the labor-intensive manufacturing industries, economic inequality and the Gini coefficient[11] were sharply reduced from 0.321 to 0.291 (Cornia, 2000; "Directorate for General Budget, Accounting, and Statistics "). Important economic policies included: promoting investment incentives, setting up export

[11] The Gini coefficient is a measure of statistical dispersion most prominently used as a measure of inequality of income distribution or inequality of wealth distribution. It is defined as a ratio with values between 0 and 1: A low Gini coefficient indicates more equal income or wealth distribution, while a high Gini coefficient indicates more unequal distribution. 0 corresponds to perfect equality (everyone having exactly the same income) and 1 corresponds to perfect inequality (where one person has all the income, while everyone else has zero income).

processing zones, reforming the financial system, carrying out a national science development plan, enacting statutes for cooperation with other countries, and announcing development plans for the growth of manufacturing industries (R. L. Chen, 2006).

From 1973 to 1983 was the age of Taiwan's developing heavy chemical industries. In the previous stage, the Taiwanese government had found that labor-intensive industries would one day lose competitiveness because of increasing labor costs and also because of competition from other NICs or developing countries. They believed Taiwan should promote heavy industry because heavy industry holds the key to industrialization as it produces capital goods and can support the long-term steady growth of the economy (Wade, 1990). Therefore, the government made plans to help enlarge the mid-stream and upstream industries, especially heavy chemical industries, which are more capital intensive, in order to reduce the cost of basic production materials for Taiwan's exports (Chu, 2003a). Thus, the representative industries of this stage included petrifaction and steel. Unfortunately, like many other countries, Taiwan suffered harshly from the dual oil crises in 1973 and 1975, which delivered a huge blow to Taiwan's heavy chemical industry and certainly for other export industries as well. Moreover, with Taiwan's withdrawal from the United Nations and the ceasing of diplomatic relations with the U.S., foreign investment in Taiwan decreased, exports declined, and the country's economic growth suddenly slowed. Due to the shock of the oil crises, the government realized that it would be difficult for Taiwan to develop industries that need intense natural resources and energy and, therefore, switched from developing capital-intensive heavy chemical industries to developing industries with high inter-sectoral linkages, high technology-intensiveness, high value added, low energy consumption, capacity for increased use of locally produced raw materials, and good marketability. These industries tended to be technique/knowledge-intensive industries, including electronics, information technology, and high-tech industries (Pang, 1992; C. L. Tsay, 1999). To facilitate this, the government set up the Industrial Technology Research

Institute (ITRI) and the Electronics Research Laboratories in 1974 and the Institute for Information Industry in 1979. All three of these institutes played a crucial role in the later development of Taiwan's information technology, high-tech industries and information economy (Cheng, 2002; Zhang & Wang, 1994). In 1976, economic inequality also reached a historical low in 1976 at a Gini coefficient of 0.280, and then gradually increased to 0.287 (Cornia, 2000; "Directorate for General Budget, Accounting, and Statistics "). The representative economic policies in this stage included: establishing the Industrial Technology Research Institute of Taiwan, promoting the Ten Projects to advance national infrastructure, establishing the National Development Fund to help the industries to start new businesses, lowering the custom tariffs to help with production material imports, making financial plans to support Taiwan's small and middle-sized enterprises, and enacting the Technology Development Program.

The period between 1984 and 1990 is known as the "economic liberalization stage," sometimes also recognized as an early-stage in Taiwan's transition to an information economy (Ho & Lo, 2002; C. F. Lin, 2004b). During this time, Taiwan's labor-intensive manufacturing confronted increasing international competition from other NICs and other developing countries (Ranis, 1992). Moreover, enormous pressure came from the U.S. seeking the liberalization of Taiwan's domestic market. At this stage, the New Taiwanese Dollar appreciated sharply due to Taiwan's huge trade surplus and foreign exchange reserves. Coupled with the increasing labor costs, Taiwan quickly lost its competitive advantage in its traditional labor-intensive manufacturing, which had to immigrate for survival, first to Southeast Asia and then to China (T. J. Chen & Ku, 1995). Not surprisingly, industrial production dropped greatly at this time, and unemployment became a serious problem (Chu, 2003d). To sustain Taiwan's economy, the government began promoting high tech and information-intensive industries to replace traditional labor-intensive industries. The strategic industries initiated by the government included information technology, telecommunication, machinery, electrical machinery, electronic

parts, transport equipment, etc. The country thus experienced a dramatic industrial transformation from labor-intensive manufacturing to information-intensive manufacturing and services (C. F. Lin, 2004b). Electronic and electronic good industries replaced textiles as the leading export in 1984 (Wade, 1990), marking the end of the labor intensive manufacturing age in Taiwan.

Also at around the same time, Taiwan's service industry, for the first time, surpassed manufacturing to become the largest contributor to the GDP and to the employment of the labor force ("National Statistics Database," 2007). Moreover, liberalization of the finance and telecommunication industries created big markets, thereby highly increasing employment in the information-intensive service industries (Chu, 2003d). This paradigm shift to an information economy was accompanied by a striking increase in wage inequality. The Gini coefficient rose from 0.287 to 0.312 (Cornia, 2000; "Directorate for General Budget, Accounting, and Statistics "), which is generally attributed to the dramatic industrial transformation from labor-intensive manufacturing toward information-intensive industries and the consequent increasing unemployment as well as to the increase in globalization and liberal market policies.

The key economic policies of this time period included assigning strategy industries, building the Twelve Projects, establishing the Science Park, lowering the nominal tariff rate to less than 10%, loosening the restrictions on outward investment, and pushing for the privatization of state-owned companies. (R. L. Chen, 2006).

The 1990s, "the age of high-tech industry," witnessed the rapid development of Taiwan's informatization and information-based industries. By placing the production sites in China, the products of Taiwanese IT companies enjoyed low production cost and high competitiveness and, consequently, became the world's IT factory, producing outsourced IT products for international name brands. Since then, Taiwan's IT production has continued to claim a lion's share of the world market. The industry most representative of this stage has been the semiconductor industry. In 1990, under pressure

from domestic businesses, the Taiwanese government started to allow companies to invest in China, which produced a second wave of the relocation of domestic plants (the first wave was the relocation to Southeast Asia) (T. J. Chen & Ku, 1995; Gong, 2005). In response to this trend, the government decided to speed up the changes to a more information and technique-intensive economy that were already taking place. It announced and executed the influential "Enforcement Rules of the Statute for Upgrading Industries" to invite investment in information-intensive industries. Meanwhile, the government itself also invested heavily in its "National Information Infrastructure" and in R&D to create a better environment for an information economy (Y. S. Ko, 2006). To encourage more investment and to avoid the continued moving out of industries, the government removed restrictions on immigrant workers in 1991 in order to lower labor costs. As a result of the industrial transformation and immigrant worker policies, Taiwan's unemployment rate surged, and the inequality of its income distribution deepened. Its unemployment rose from 1.67 to 2.99% and the Gini coefficient grew from 0.312 to 0.326 ("Directorate for General Budget, Accounting, and Statistics "). Particularly noticeable was that high unemployment kept setting historical records ("National Statistics Database," 2007). The representative economic policies in this stage included the Statute for Upgrading Industry, the Six Year Plan for National Development, the Small and Medium Sized Enterprise Development Statute, the Asia-Pacific Regional Operations Center Development Plan, and White Paper on Science and Technology.

From 2000 until the present, the Taiwanese government has been engaged in "developing knowledge-intensive industries" (T. J. Chen & Lee, 2004b), with Taiwan's IT industry maintaining its crucial position in the world's IT production. At this stage, the government and businesses have continued investing heavily in technological R&D and a knowledge economy. The government has set specific goals that the national R & D budget should reach 3% of the GDP, that technological enhancement should contribute to at least 75% of total economic growth, and that knowledge-intensive industries should

account for at least 60% of the total GDP by 2010. However, in 2001, the world's economy, especially related to the IT industry, suffered from a severe recession; Taiwan had its first historical economic negative growth (-2%), and the unemployment rate and inequality of wages both hit an all-time high. Since 2003, while economic growth has gradually climbed back to normal rates of 4-5%, the unemployment rate and wage inequality still remain at a much higher level than before. During this period, unemployment hit the highest point in Taiwan's history at 5.17% in 2002 and the Gini coefficient also set a historical record at 0.35 in 2001. Therefore, this knowledge economy is also characterized by the highest unemployment rate and highest income inequality in Taiwan's history ("National Statistics Database," 2007). The representative economic policies of this period included the Knowledge-Based Economies, the National Development Plan, the Master Industrial R & D Professional Supply Plan, and the Branding Taiwan Development Plan.

THE DEVELOPMENT AND HISTORY OF TAIWAN'S INFORMATION ECONOMY

Now we are going to draw our attention to the developmental history of Taiwan's information economy, which can be broadly grouped into three stages: The stage of being initiated by foreign capital (1954-1984), the stage of being incorporated into the global production system (1985-1992), and the stage of global production and extension (1993-the present).

The Initiation Stage by Foreign Capital (1954-1984)

The earliest development of Taiwan's information industry was initiated by foreign businesses, mainly from the U.S., and Japan, but also including some from Europe. At the beginning of the 1960s, U.S. electrical and electronics firms began to examine opportunities for relocating production to cheaper labor sites. The objective was to cut costs by getting the labor-intensive part of semiconductor manufacturing—connecting the wire leads and packaging—done more cheaply than was possible at home.

The year 1961 thus represents a landmark in the history of East Asia. It is the beginning of the corporate strategy that came to be called global manufacturing or purchasing around the world wherever components could be obtained at the lowest cost. Of all the regions of the world, East Asia benefited most from this strategy (Wade, 1990).

NCR, IBM, and Phillips all set up factories, branch companies, or international purchasing offices (IPO) in Taiwan at this time, to take advantage of Taiwan's cheap, high quality labor. The main players in the industry at this time were almost all foreign firms, and Taiwanese companies could only do the very low level and labor intensive peripheral parts. Around the same time, there were also some small Taiwanese companies that started sub-outsourcing integrated circuit (IC) packaging, which is very labor intensive and does not require high level skills (M. S. Chen, 2005).

Nevertheless, as more and more companies funded by foreign capital came to Taiwan to establish their factories, starting from the 1970s, some of these foreign companies began to practice technological cooperation with local Taiwanese companies such as Tatung, Sampo, TECO, and Panasonic. This cooperation fired the growth of these local companies and also Taiwan's consuming electronic industry, by producing items such as television sets and radios. Moreover, instead of producing only low-skilled parts, these transnational IT companies also started to produce more critical parts with higher need for knowledge and technique in Taiwan, which helped train numerous professional personnel for Taiwan's later upgrade to information industries. At this point, local Taiwanese computer companies such as Acer and MiTAC started to appear even though they were very small. However, these local computer companies produced only low level computer parts and IT. Therefore, although Taiwan had created some information hardware companies at this stage, they were mainly labor intensive and low technique orientated companies that provided such things as IC packaging and low level IT parts.

As for the international context, several events at this stage influenced the growth of Taiwan's information economy. In the 1970s, some Japanese corporations transferred

some medium value-added production processes to Japan's East Asian neighbors, enhancing the industrial upgrading of Hong Kong, Singapore, South Korea, and Taiwan, and elevating them into Newly Industrialized Economies (Lai & So, 1997).

In the computer industry, the transistor replaced the vacuum tube, which expanded the IC industry, enhanced computer performance, and thus promptly expanded the market demand for information products (Hsu, 1999). Later in 1982, IBM started to sell high performance but inexpensive personal computers (PCs) and adopted an open system for computer parts, which gave other countries opportunities to get involved in computer part production (M. S. Chen, 2005).

As for the government and its role during this period, due to the political and economic impact of the oil crisis and Taiwan's difficult political situation as it was withdrawing from United Nations and also breaking off diplomatic relation with the U.S., plus the U.S. adopted quotas on Taiwanese importation products to the U.S. market, Taiwan not only faced serious economic hardship but also a political challenge for the Kuomintaung's (The Chinese Nationalist Party) governance. The successor and also the son of Taiwan's dictator (Chiang, Kai-Shek), Chiang, Ching-Kuo, faced a very difficult political economic situation. In order to maintain and strengthen his political power and the legitimacy of his government, he had to maintain economic stability and economic growth to win people's support of his governance. Knowing that labor intensive manufacturing would sooner or later lose competitiveness because of the mounting labor costs in Taiwan, he quickly decided that promoting technology in the economy, upgrading Taiwan's industries, and developing information industries were three important ways to help Taiwan's economy survive the international and political economic hardships.

In addition to making plans for Taiwan to acquire semiconductor design and production capabilities as early as 1972, the government also convened the first Scientific Technical Conference, and at the conference, a Scientific Technique Development Plan

was proposed, which included: developing technologies for energy, materials, information, and automation； constructing the Hsinchu Science Park for information industry development；inviting overseas technological professionals to come back to Taiwan to help with the establishment of Taiwan's information economy ； and constructing the Technical Advisory Committee that would include both foreign and domestic experts to help develop information economy policies. Furthermore, the Ten Year Economic Development Plan was also determined at this conference and information, electronics, electronic machine, machine, and transport equipment were assigned as strategic industries, which could thus enjoy tax rebates, low interest rates on loans, and also technical support from the government. These strategic industries were believed to have more added value, to use less energy, and to require more skill and technique, which better fit the desired direction of Taiwan's future economic development (M. S. Chen, 2005).

Moreover, in order to deepen the R & D capacity for these strategic industries, the Industrial Technology Research Institute of Taiwan, R.O.C. (ITRI) was established in 1973, which later played a crucial role in offering technical support to the information companies, making important contributions to the growth of Taiwan's information economy (Wade, 1990).

The Taiwanese government also tried to upgrade the quality of workers to meet the needs of new industrial development. The government started advocating vocational skill training education and technological education as well as establishing the vocational education system at this time (Day, 2005).

Generally speaking, by the late 1970s, government officials had begun to envision an integrated information industry for Taiwan, linking semiconductors, computers, computer software, and telecommunications. They gave it very high priority. A newly formed information industry task force headed by two senior cabinet ministers reported

directly to the premier. A comprehensive approach to the information industry was spelled out in the Information Industry Development Plan for 1980-89 (Wade, 1990).

In 1980, as designated in the Scientific Technique Development Plan, the Hsinchu Science Park was established. Companies in this park could enjoy tax rebates, technical support from the government, preferential interest rates for loans, and also subsidies for R & D costs. The Hsinchu Science Park thus became the most significant site that attracted a considerable amount of domestic and also foreign investment in the information industry (R. L. Chen, 2006). In addition to the policy benefits the government offered to encourage investment in the Hsinchu Science Park, the learning and networking effects of this geographic gathering were also important factors in the growth of Taiwan's information economy (M. C. Tsai, 2005). First of all, through having a common location in the Hsinchu Science Park, companies can have closer interactions, which speeds new technique and knowledge diffusion among different companies. Second, IT technicians and professionals in the Hsinchu Science Park have also built an informal technical knowledge interchange network, which is recognized as a kind of technical community where IT professionals can share their working knowledge. Third, because many of the IT professionals that were hired to work in the Hsinchu Science Park had been working in the Silicon Valley and had close relationships and collaboration with the Silicon Valley, a Hsinchu-Silicon Valley connection was established. Through this connection, Taiwan can follow or even keep step with new and advanced IT production techniques and knowledge and also have more opportunities to have technical cooperation with the U.S. IT companies (M. C. Tsai, 2005). These three reasons have all contributed to the quick success of Taiwan's information economy. Later in 1997 and then in 2003, the government built the second and the third Science Parks—the Tainan Science Park and the Taichung Science Park respectively, which, according to the government's plan, will form a labor division of North-IC, middle-nano-scale technology, and South-photoelectric for Taiwan's information economy.

In 1982, the second Scientific Technique Conference was held, and in the conference, IC, machinery, electronics, and information, again, were assigned as the strategic industries that would receive the government's support. In the next year, the government passed the Statute for Upgrading Industry to give these new strategic industries a 20% tax rebate, preferential interest rates for loans, and also subsidies for R & D, automation, and employee training.

Overall, although the development of Taiwan's information economy was initiated by foreign capital at this stage, after the 1970s, through the efforts of Taiwan's government, ITRI, Taiwanese enterprises, and domestic and overseas Taiwanese IT experts, Taiwan very quickly developed a strong information economy. Moreover, with its striking successes in the export of PCs and relevant parts, Taiwan came to hold third place in the world's IT production in the early 1980s. At this time, the IC industry also started to reveal its increasingly considerable importance to Taiwan's economy.

The Stage of Being Incorporated into the Global Production System (1985-1992)

In the 1980s, the rapid globalization trend quickly influenced the whole world's economic system, which also changed Taiwan's competitive advantages in the global market. More and more NICs and developing countries, such as those in Southeast Asia, with their cheaper labor costs, challenged the status quo of Taiwan's labor-intensive manufacturing industry. The Taiwanese government and companies in Taiwan had no choice but to look for new comparable advantages in the global market in order to maintain Taiwan's economic growth and business profits (C. L. Tsay, 1999). Also, within Taiwan, the economy faced the problem of the extensive appreciation of the new Taiwan dollar, the upsurge in land and labor prices, and also the questions and opposition from the environmental and labor movements. These all inevitably raised the production cost of manufacturing in Taiwan, particularly for labor-intensive manufacturing. To solve

these problems, the government at this time had already decided Taiwan should develop technique/information intensive industries instead of relying on labor -intensive or heavy industries, to maintain its previous striking economic performance (W.-H. Tsai, 2005).

By this stage, after being tested by transnational IT name brands through outsourcing or technical cooperation, Taiwanese IT companies had already won transnational IT name brands' trust in their production capacity and product quality, and thus began to receive original equipment manufactures (OEM) orders from international IT companies. For example, in 1985, MiTAC first received the U.S. telephone and telecommunication company—ITT's OEM orders for producing PCs, the first landmark partnership between Taiwan's IT manufacturers and international IT name brands (Hsu, 1999). Later on, more and more international IT name brands followed suit, placing OEM orders with Taiwanese IT manufacturers to produce PCs, IC, laptops, other IT products, and relevant parts. Through these outsourcing relationships, Taiwanese information industries were gradually incorporated into the global IT production network.

Later, in addition to production, the R&D capacity of Taiwan's IT manufacturers started to show their maturity and potential. Taiwan's production capacity for PCs had caught up to the level of international brands and was also able to develop its own brands to compete with other international name brands. Nevertheless, although Taiwanese IT companies had a stronger IT production ability, the very crucial parts of the PCs such as the microprocessors, the production knowledge, and techniques were still controlled by U.S. and Japanese companies, which meant that Taiwanese IT companies could only produce less profitable IT parts or products and had to face a very competitive market where its products were compared to those of the Japanese and American IT companies.

Moreover, there were more and more companies entering IT production, resulting in severe competition for IT outsourcing and production, further lowering profits. Faced with this situation, Taiwanese IT companies had to pursue an economy of scale by extending production size, adopting automation, improving the production processes, and

using modulization to simplify the fabrication and reduce the amounts of parts used in order to lower production cost and maintain price competitiveness.

In the middle 1980s, the world market encountered a recession. Taiwanese IT companies, especially the hardware companies, faced withering markets, increased costs, and an even more deteriorated competitive situation. Many firms had to improve their marketing strategies, to begin integrating their high, middle, and low-stream industries, to change their organization structure, or even had to move their production sites to Southeast Asia for cheaper labor.

In 1987, one of the most significant IC companies in Taiwan, the Taiwan Semiconductor Manufacturing Company Ltd., was established through investment by the Taiwanese government and technique and personnel transfer. The Taiwan Semiconductor Manufacturing Company later contributed considerably to the growth of Taiwan's semiconductor industry by creating industrial diffusing effects, driving the development of IC industries that could manage the entire process from upstream to downstream (from high to low in order as IC design, IC production, and IC packaging) (M. S. Chen, 2005; Chu, 2003a). By the 1990s, the Taiwanese semiconductor industry had already shown excellent performance in making profits and could also produce high technique level IC products, under the government's push and support for technique advancement, increased investment by entrepreneurs, many overseas IC professionals' coming back with their techniques and knowledge, and the learned skills from the cooperation with the transnational IT companies (M. S. Chen, 2005).

After 1989, there was a wave of overseas Taiwanese Americans who had worked in the Silicon Valley coming back to Taiwan to establish IT companies. With their years of experience working in U.S. IT companies, these professionals brought back important knowledge, experience, and also technique, contributing to Taiwanese IT companies' operation, production, and management. They also helped form a close technique

connection and interaction with the Silicon Valley, which is also called the Silicon Valley-Hsinchu connection or reciprocal regional industrialization (M. S. Chen, 2005).

Furthermore, the growth in information-intensive services after the mid 1980s also played a role in the development of Taiwan's information economy. Owing to the liberalization pushed by the Taiwanese government and also to the new development of telecommunication technologies such as cell phones, the finance and telecommunication market had substantial growth, as well as the employment in these industries (Chu, 2003d). Newly emerging information-intensive service activities provided numerous job opportunities, which more than offset the loss of jobs from the rapidly migrating labor-intensive manufacturing production lines (T. J. Chen & Lee, 2004a).

Toward the end of the 1980s, as the price of PCs continued dropping, the international IT name brands were less and less able to produce IT products in their homelands because of the much higher labor cost. Taiwan's role in IT production in the global market consequently became more and more significant. Moreover, IT companies funded by foreign capital gradually withdrew from Taiwan because of the increasing labor cost and also because the cost of outsourcing was much cheaper than running a branch company. Thus, outsourcing strategies such as OEM and original brand manufactures (ODM) became the mainstream of Taiwan's IT production at this time and also became the main cooperation mode with international IT name brands, especially the U.S. brands (Hsu, 1999).

As for the Taiwanese government during this stage, it continued the policy of helping improve Taiwan's information economy. For example, the government drafted a Ten Year Development Plan for the information industry sector, which pushed the IT industry to grow in the direction of more high-tech and more technique-intensive development. Furthermore, in 1991, Taiwan's government passed the Statute for Upgrading Industry to replace the Statute for Stimulating Investment to equally focus on encouraging industrial upgrading activities such as R & D and employee training and not

only on encouraging the establishment of new industries. However, the government still claimed telecommunication, information, semiconductors, consumer electronics, precise machinery and automation, aerospace, and so on as Taiwan's ten high-tech strategic industries, which could still enjoy the investment rewards of tax rebates and preferential interest rates. The aim of the Statute for Upgrading Industry was to help accelerate the economic and industrial transformation to a technique and knowledge-intensive information economy. In the same year, the government also enacted a Six Year Plan for National Development, which also focused on the ten high-tech strategy industries, but its main purpose was to build and offer infrastructure resources for these industries (J. H. Wang, 2003).

As for education policy, it was focused on training technological professionals. The government executed industrial personnel training programs and also established numerous institutes of technology to increase the supply of high level technology personnel (Day, 2005).

In 1990, Taiwan's government announced the administration rules for investment in and technical cooperation with China, allowing Taiwanese companies to invest in China. This induced the second wave of immigration of Taiwan's labor intensive industries (the first was when many relocated to Southeast Asia). In this wave, some labor intensive IT industries or labor intensive sectors of IT companies (such as lower level electronics and electronic machinery or IC packaging) moved out as well. The loss of these industries caused Taiwan to encounter the threat of industrial hollowness and economic stagnation. Luckily, in order to punish Japan for dumping computer memory chips in the American market, the U.S. taxed Japanese PCs with a 100% punishment tax, which gave Taiwanese IT companies great opportunities to receive more U.S. IT name brands' outsourcing orders. This timely opportunity made the production of PCs become the new pillar of Taiwan's economy. Similarly, the U.S. government under President Clinton pushed the information infrastructure, causing a rise in the demand for computers

and Internet products, which also revived IC industries (IC industries had been in recession for a while at that time). Because of these policies, Taiwanese IT companies advanced to a even more crucial position in the global IT production network through OEM and ODM for the U.S. IT brands (M. S. Chen, 2005).

Therefore, generally speaking, from the late 1980s to the early 1990s, Taiwan's economy experienced a dramatic transformation. The labor intensive industries declined, and instead, the information economy, which included information intensive manufacturing as well as information intensive service, came to hold the primary role in Taiwan's economy. By this time, labor intensive exports had declined from 47% in 1986 to 36% in 1995, and then remained stable (Chu, 2003a; Ranis, 1992). Thus, entering the 1990s, Taiwan's information industries held a significant position in the world's IT market and production.

The stage of Taiwanese companies' global production and extension (1993- the present)

After becoming an important player in the world's IT production, especially in the production of PCs, monitors, IC, motherboards, graphics cards, keyboards, scanners, and computer mouses, more and more Taiwanese IT companies were seeking a more global role in production and management (M. S. Chen, 2005). There were two main reasons for this: First, in order to offer products and services closer to the markets, companies have to build fabrication factories and also a global fabrication network. Second, the production cost in Taiwan had increased, especially due to increases in the price of land and labor, pushing the immigration of the labor intensive sectors of IT industries to other countries with lower labor costs. These reasons both accelerated the formation of a global production network of Taiwanese IT companies (Hsu, 1999).

As for the new production sites, the major locations of Taiwanese IT companies factories abroad included not only traditional sites such as south-east Asia and China but also locations close to North America and Europe, such as Mexico and Scotland. Among

these new factories, there were two main kinds—production and fabrication. Although the labor intensive sectors had left Taiwan, the most technique intensive sectors still stayed for the higher quality labor and also for industrial research resources. The sectors or industries moving out were primarily mature products with a longer product life cycle that required simpler production techniques (Hsu, 1999).

Moreover, Taiwanese IT companies were seeking to get involved in the production and development of key parts in order to have more stable sources of these parts and also to lower the purchasing cost. At this time, because the Japanese yen appreciated to a very high extent, placing the Japanese IT brands' at a competitive disadvantage, Japanese IT companies started to speed up the immigration of their domestic production and also reinforced their cooperation with Taiwanese IT companies to produce the key IT parts, which gave Taiwan a perfect chance to upgrade its IT industry again.

The engine driving the growth of Taiwan's information economy had also changed. Since 1994, Taiwan's IC industry had not only produced for the domestic market, but also for export, which largely raised the percent of IC products in Taiwan's exports and also the amount they contributed to the total GDP (M. S. Chen, 2005). In contrast, after 1995, when computer industries became more mature and then started to move out from Taiwan, the computer industry's economic significance steadily declined, and thus IC industries took the place of computers, playing the primary role in Taiwan's economic growth at this stage (M. S. Chen, 2005).

By the mid 1990s, Taiwanese IT industries already had the ability to do R & D and also to advance production techniques by themselves, breaking their past reliance on the government's technical support and professional personnel transformation (M. S. Chen, 2005). Over the last few years, the government's role in the information economy development has continued to decline.

While in recent years the government has still tried to promote economic growth through policy instruments, their industrial policies have changed to focus more on knowledge economy "activities" themselves (particularly R & D), not only on subsidizing the industry. According to the government's plan, the industrial incentives should help the information-intensive manufacturing turning to technique/knowledge intensive high-tech industries, by increasing investment in R & D and by advancing production technique (H. M. Tsai, 1999).

Thus, the government proposed a plan to develop Taiwan into a technology island— including the development of Taiwan as an R & D center, a high-tech production center for the Asia Pacific Zone, and also a technological society. In 1999, Taiwan's government passed the Science and Technology Basic Plan to help strengthen the knowledge economy industries (T. J. Chen, 2004). In addition, the New Century National Development Plan set forth a plan to change Taiwan into a green silicon island, to become the primary global high-tech manufacturing and service center. The detailed plans incorporated encouraging international and domestic companies to establish research centers in Taiwan, introducing new technology products into Taiwan, enhancing Taiwan's hardware and software infrastructure for a knowledge economy, and developing advanced computer, semiconductor, and broadband industries and technology. The final goal was to set up a cooperation mode by which Taiwan is in charge of producing the IT key parts, then sending the orders to China for material processing, then exporting to the world market. The government hoped to push Taiwan to transform from OEM to ODM, then to original design logistics (ODL) and finally to reach the goal of having global logistics (GL).

In August 2000, the Taiwanese government also passed the Knowledge Economy Development Plan, setting up economic goals for the next ten years which included making R & D investment over 3% of the total GDP, raising the contribution of technology advancement to economic growth to 75%, making knowledge and

information-intensive industries count for over 60% of the total GDP, and raising the rate of broadband installation to be around the same as the U.S.. The detailed sub-plans contained provisions for helping to grow innovative industries and enterprises, constructing an environment for Internet development and application, expanding the application of IT and Internet in production and also in daily life, such as the electricalization of small and middle-sized enterprises, constructing an electronic government, and improving the education system to give students more capacity to innovate.

In 2002, the Six Year Plan for National Development, arranged to establish IC technical design schools and digital content colleges, attracted high-tech professionals to Taiwan, developed industrial technology schools for each strategic industry, and proposed a plan for high added value in traditional industries and for constructing more industrial science parks.

After the industry upgrade of the 1990s, Taiwan has become the biggest production site of IT hardware products in the world (Hsia, 2003). The products that international IT name brands purchase from Taiwan have shifted from the original lower level products/parts to semi-finished PCs, laptops, liquid crystal display monitors, and other higher-level products. Furthermore, the OEM relationship between Taiwanese companies and international name brands has also gradually transformed to ODM, ODL, or even GL. Inevitably, more and more Taiwanese IT companies have also tried to create their own brand products to lower the risk of relying only on outsourcing orders (Hsu, 1999).

As Taiwan's information industry has become more mature, companies have had to start developing new markets in other fields such as telecommunications or the Internet. In addition, more and more Taiwanese IT companies have moved their production sites to China. While Taiwan is and will still be one of the most important outsourcing sites for Euro-America's high-tech products, the profits are not from

production as before, but from design, development, and testing and improvement of production processes.

To face the challenges of more and more mature IT industries moving from Taiwan to China and also the increased competition as more and more NICs were joining the IT production markets, in 2002, the Ministry of Economic Affairs started planning to develop the ten new potential knowledge/high-tech industries such as the nano-scale application industry, the digital content industry, the semiconductor precise equipment industry, LCD industry, technique trade services, the waste reuse industry, R & D services, and the technology design industry.

In summary, Taiwan's information economy is successful due to five main reasons: policy, financial, and technical support from the state (Amsden, 1985; Wade, 1990), economics of scale production (through the model of global outsourcing) (A. Amsden & W. W. Chu, 2003), the learning effects from geographic gathering of companies such as can be found at the Hsinchu Science Park, the transnational technical networking and cooperation with transnational IT name brands, and the corporate synergy network among Taiwan's big, medium, and small IT enterprises (this will be discussed in later sections). Other important reasons also include the high quality of Taiwan's human capital and the government's investment in the information and telecommunication infrastructure.

STATE AND INFORMATION ECONOMY DEVELOPMENT

What are the typical functions of a government in the processes of informatization in a country? With a special focus on the developing countries, Katz (1988) examined the influence of the state on the speed of informatization and the social transformation to an information society. He argued that, unlike industrialized countries, where the process of informatization is mainly determined by economic factors, informatization in other

countries is more likely determined by some political factors such as the countries' internal patterns of power, influence, and resource allocation policies as well as by the their political interdependency at the worldwide level. He offered empirical evidence to demonstrate that in both the information workforce transition and the diffusion of information technologies processes, politics, or the state, repeatedly plays an important or even decisive role, especially in the case of developing countries. In his case study of governments' role in influencing the diffusion of media-receiving equipment, he identified four mechanisms through which government influence is exerted. First, regulation can act to control access to the media and, in turn, their signals, thereby restricting the diffusion of receivers. Second, by implementing import controls, policy-makers can restrict access to media-receiving equipment or computers. Third, import substitution policies that affect the pricing structure of hardware can greatly delay the computerization of local films. Finally, by controlling telecommunications agencies, the government can effectively control the supply of services to the population (Katz, 1988). Other means include control of market access, regulation of the electromagnetic spectrum and spectrum allocation policies, and industrial policy in its larger sense.

Although information systems may react to the needs emerging from the economy, such reactions are oftentimes mediated by the political system (Katz, 1988). With the political influence as the foreground for his research, Katz did not overlook the role of economic factors. His analytical model indicates that economy, politics, and technology all interact and influence each other. The causal links among these three are all bi-directional. Katz (1988) pointed out the importance of the industrial sector on the process of informatization. According to him, parallel to the process in which some states were heavily invested in communications and information infrastructure in order to facilitate economic growth, the private sectors in these countries underwent structural changes and adopted information technologies with the view of improving productivity

on the part of workers. Thus, along with the state, the industrial and private sectors were also a major driving force behind the diffusion of information technologies.

Katz's viewpoint regarding the role of the state in using informatization to promote economic development and to pursue economic goals is valid in the case of Taiwan. Many scholars are convinced that the most striking feature of Taiwan's information economy development is the leading role that the state has played in the process of offering incentives for investment in IT industries, helping capital accumulation, stimulating or even directing R&D activities, helping professionals be trained, and most importantly , promoting industrial transformation toward information industries (Chou, 1998; Chu, 2000, 2003a; Y. S. Ko, 2006; van Hoesel, 1999). Thus, in the next section we are going to discuss the literature with respect to the influence of the developmental state—the Taiwan government and other interest groups on the processes of informational economy development.

THE DEVELOPMENTAL STATE, THE TAIWANESE GOVERNMENT, AND OTHER INTEREST GROUPS

When considering Taiwan's information economy, we cannot ignore the crucial and active role that its government has played in this process. Throughout the post-war history, the government's economic developmental policies have been viewed as having a determinant and far-reaching influence on Taiwan's industrial development, economic performance, capital accumulation, labor market structure, and income distributions (H. M. Tsai, 1999). For instance, according to Amsden (1985), the Taiwanese government positioned itself to prevail on key economic parameters such as the size of the surplus extracted from agriculture and the rate of profits in industry. Moreover, the success in export-oriented industrialization and the development of IT industries can also be largely attributed to government promotion (Chu, 2003a, 2003c). Some specific policy instances that the Taiwanese government has adopted range from land reform, import substitution

and export promotion, strategic industry promotion, industrial policy, technology policy, as well as education and human capital policy. Because of the governments' decisive role in their economic development, Taiwan and several other East Asian countries such as Singapore and South Korea are viewed together as the models of developmental countries where a centralized state interacts with the private sectors from a pre-eminent position so as to secure national development objectives (Johnson, 1982; White, 1988).

Wade's research (1990) revealed that using incentives, control, mechanisms to spread risk, and instituting economic policies enabled the Taiwanese government to guide, or govern, the market processes of resource allocation. As a consequence, the country was engaged in different productions and investments than would have occurred if more of the resource allocation and production decisions were left to the free market. The Taiwan government in this particular case guided the market through: (1) redistributing agricultural land in the early postwar period; (2) controlling the financial system and making the private financial capital subordinate to industrial capital; (3) maintaining stability in some of the main economic parameters that affect the viability of long-term investment, especially the exchange rate, the interest rate, and the general price level; (4) modulating the impact of foreign competition in the domestic economy and prioritizing the use of scarce foreign exchange; (5) promoting exports; (6) promoting technology acquisition from multinational companies and building a national technology system; and (7) assisting particular industries (p.27-28).

The existing research so far has not yet answered two very interesting questions: how were these powerful and effective industrial policies determined, and what were the relationships among different interest groups and states? At least before the mid-1980s, industrial policy-making in Taiwan took place merely within a narrow coalition, which at the core included the technocrats and ministers of the central economic bureaucracy, plus the senior managers of the public enterprises and the public research organizations, with the ultimate veto power securely held by the Nationalist party leaders and military

leaders. At the margins of the decision-making process were some selected managers of large foreign and domestic firms. Small business people, workers, and peasants were effectively excluded. While formal mechanisms to solicit views from the private sectors on economic policies were almost nonexistent, informal contact was frequent. Business people were preoccupied with building up contacts in the government and the party. To do so, they might have had to rely on connections established through kinship, school, military service, or some demographic commonalities. Big companies generally employed several people who had certain connections with the government and the party. They might be called "the public relations managers" (Wade, 1990, p. 286). However, after the mid-1980s, with the democratization of Taiwan, the balance of influence between the state and the interest groups began to shift toward more equality. The preferences of the political leadership and bureaucrats have become less determinant of a factor in terms of policy decisions. The government deliberately started to make the policy decision-making network more inclusive, with a view to include more input from industrialists, financiers, and other groups. For example, the Ministry of Economic Affairs has been making efforts since the 1980s to seek feedback from various private sector groups on draft legislations before they were submitted to the cabinet. In many ways, the policy decision-making process has been significantly strengthened.

As far as worker groups are concerned, before the 1980s, labor union organizations and activities were tightly controlled. Most unions were based on the company rather than on the occupation, with the occasional exception of a few countywide unions for specialized workers such as the welders. Unions' financial resources were restricted by law, and the union leaders were usually paid by the company by which they were employed. The right to strike was explicitly prohibited by martial law. All unions within the county were organized into a country federation, tightly under strictures imposed by the party. There were also several inactive provincial associations of county federations, staffed by some life-long party-appointed officials with no contact

with the rank and file. The availability of private safety nets such as the retail trade and family income-pooling, together with the long-standing shortage of many kinds of skills, further weakened the power of labor unions (Wade, 1990). However, along with the development of globalization and the rapid rise of labor cost, the relationships among the government, businessmen, and workers seem to have changed. In the past when businesses were less internationally mobile, they saw the economic nationalism of the developmental state as supportive of their interests; whereas now as they have become more mobile, they start to see it increasingly as an impediment to their worldwide quest for profits. Moreover, globalization and free trade doctrines have also neutralized the effectiveness of many developmental policy instruments. With the policies of industry assistance gradually scaled back over time, the Taiwanese government has focused more on the build-up of the technological capacities, in particular those related to information technologies, within the country. On the other hand, those big and internationally mobile firms may have become less willing to make major and long-term investments themselves in the technological capacities at home, and therefore tend to refrain from the provision of support from the government.

Workers, however, cannot be relocated nearly as easily as capital. Thus it has become a matter of crucial importance to them that the government and the firms make long-term investments to expand the technological capacity as well as the domestic demand for labor within Taiwan. From this perspective, the government and the labor force seem to share more common interests in building a consensus of support for long-term and nationally focused means in order to counter-balance oppositions from those owners and managers of internally mobile capital (Wade, 1990).

POLICIES OF TAIWAN'S INFORMATION ECONOMY

Overall speaking, Taiwan, on the one hand, advanced its IT production capacity and learned advanced techniques by participating in the international market and cooperating with transnational IT name brands. On the other hand, Taiwan's government also adopted different kinds of policies to help promote information economy development and industrial upgrading. Thus, the government policies, especially the industrial policies, did play a crucial role in the history of Taiwan's information economy.

Taiwan's state policy and intervention has relied on organizational and institutional links between politically insulated state agencies and major private sector firms. The effectiveness of state intervention has been amplified through the fostering of state-linked private sector conglomerates, banks, and general trading companies that dominate strategic sectors of the economy. Underlying these political and institutional requirements for effective state intervention in the form of policy are two central features, namely, the unusual degree of bureaucratic autonomy and public-private cooperation. The coexistence of these two conditions has allowed the Taiwanese government and the bureaucratic elites to fulfill independent national goals and, in the subsequent stage, to translate these broad national goals into effective policy action (Onis, 1991).

In this section, we are going to draw attention to the policies relevant to the development of the information economy to further understand how the government functioned during this process.

Economic policies can be generally grouped into the following categories: industrial policy, fiscal policy, monetary policy, exchange rate policy, trade policy, investment policy, wage and price policy, market and competition policy, energy policy, and environmental protection policy. However, in addition to the above economic policies, others such as technology policy, education and human capital policy, immigrant worker policy, industrial automation, and electronic business policy could also

have had considerable influence on the development of Taiwan's information economy. This section will explore these relevant polices to further understand how the government (the developmental state) functioned in the process of supporting Taiwan's information economy.

Industrial Policies for an Information Economy

Industrial policies can also be further categorized into four different kinds of perspectives: Industrial development policy, industrial competition policy, industrial support policy, and industrial infrastructure policy. Industrial development policy is concerned with the government's choosing of which industries to support in coordination with national economic and industrial development goals. Industrial competition policy is using the government's influence on taxes, wage rates, labor conditions, exchange rates and so on to affect the domestic industries' international competitive capacity. Industrial support policy, on the other hand, includes government's assistance for R& D, personnel training, and technique transfer. Finally, industrial infrastructure policy is the government's assistance in constructing a sound industrial environment by building science parks, ports, highways, or a telecommunication infrastructure, for example.

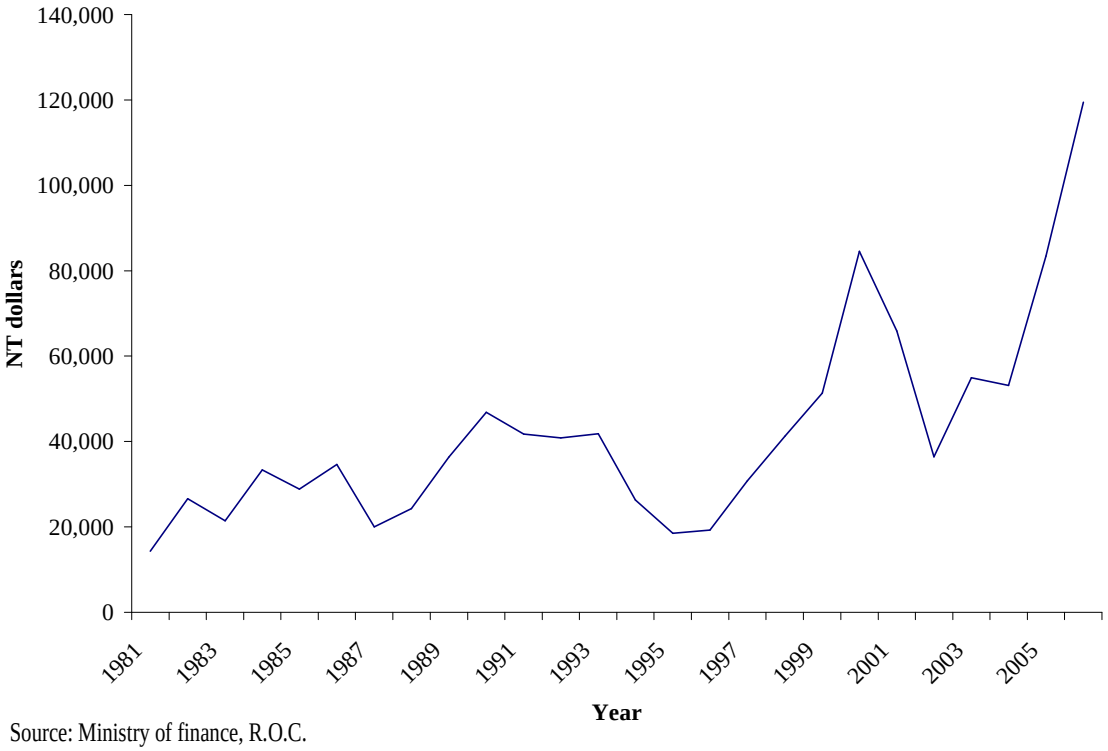
1. Industrial Development Policies

In order to assist with the growth of Taiwan's information economy, Taiwan's government proposed the following industrial development policies:

1.1. Strategic Industry policy:

Assigning information industries as strategic industries and supporting them in various ways was a very powerful policy instrument that enabled the government to channel domestic resources to the industries that the government planned to support. The basic criteria for the choice of strategic industries involved the high elasticity of demand in world markets plus the potential for rapid technological progress and labor

productivity growth (Onis, 1991). The detailed support plan included helping these industries get cheaper land; giving them tax rebates, offering them preferential loan agreements, offering them strategic industry funds or preferential financial funds; offering them technical support; transferring professional personnel; and also, helping to create a sound infrastructure. The strategic industries were assigned by the national Scientific Technique Conference. For example, in 1979, four industries were chosen as the strategic industries—information, automation, energy, and materials; the next year biological technique, photodiode, and two other industries were added. In 1993, it was telecommunications, information, consumer electronics, semiconductors, precise machinery, automation, aerospace, advanced materials, specialty chemicals, pharmaceuticals, medical services, and pollution prevention that were assigned as the ten strategic industries. Figure 4 shows us the changing amount of tariff rebate for the last twenty-five years, with a still growing trend reaching a historical high point at 2006.



Source: Ministry of finance, R.O.C.

Figure 4. Tariff rebate for strategic industries

1.2. The Development Plan for the Information Industry:

In 1980, 1982, 1990, and 1992, Taiwan's government executed four development plans for developing the information industry. In 1980, the ten year plan intended to build up the export oriented information industry. This plan detailed goals such as driving information industry development; promoting computerization in order to open up the domestic market for the information industry; importing high-tech technique; training IT professionals for industrial needs; constructing a sound research environment for IT industry growth; and building up the information infrastructure.

The 1982 executive plan focused on improving the investment environment for information industry, picking promising IT products to which to give specific assistance, and enhancing the assistance for IT businesses.

The 1990 ten-year plan had three main intentions: to develop the information software industry, to promote key/high-technique IT part industries, and to disseminate the application of information techniques in businesses and industries. The concrete plans included building IT software science parks, allocating funds for researching promising new information technologies, and striving to host the World Information Technology Fair.

The 1992 five-year plan proposed to enhance Taiwanese IT products to higher tech levels and to speed up industrial upgrading. Specific plans outlined government investment in crucial but high cost and risk product production, the support of products/industries which were promising but also fit Taiwan industrial goals; and plans to develop new products that had the potential to dominate markets (Hsu, 1999).

1.3. The Development of Critical Components and Products Act

The government also passed the Development of Critical Components and Products Act in 1992 to select 66 products for import substitution in order to reduce a

persistent trade deficit with Japan. The government openly asked domestic companies for the development plans for these products and offered free funding for 50% of the product development cost and furthermore offered interest free loans for another 50% of the development cost (Chan, 2004). Despite a bias on the part of domestic users of high-tech components in favor of imports, scarcities of such components promised high prices and high profits for firms that could make them instead of import them. Users of such inputs had an added incentive to make them in-house in order to stabilize their supply. For its part, the government became committed to import substituting high-tech components to prevent hollowing out—the movement of manufacturing jobs overseas (A. Amsden & W. W. Chu, 2003).

1.4. The Knowledge Economy Development Plan

In the early 2000s, after more and more countries joined IT production markets, Taiwan's government became more eager to seek higher level industries and economic modes to maintain economic growth, and they believed a knowledge economy would be the answer. The government proposed to encourage economic activities that were primarily related to knowledge or knowledge production. The government also tried hard to improve the business environment to better fit with investment in knowledge industries.

In 2001, Executive Yuan passed the Knowledge Economy Development Plan, which had 57 sub-plans and was expected to be accomplished in five years. Some of the main objectives of this plan were to nurture new innovative industries and enterprises, develop new technology products, and put more emphasis on R & D for innovative techniques, technologies, and products. The qualified industries or enterprises could enjoy the same preferences as strategic industries did and in addition to that, the government also offered 30 hundred million NT dollars to help industries develop innovative and promising industrial techniques, technologies, and products. The specific goals of this plan included: making R & D expenses count for 3% of the total GDP in ten

years; working towards having technology account for 75% of economic growth; making investment in education account for 7 % of the total GDP; making knowledge-intensive industry production account for 60% of the total GDP; and working toward the use rate and installation rate of broadband being the same as the U.S. (Y.-S. Ko, 2006).

1.5. The Challenge 2008 National Development Plan

To make concrete progress toward realizing the vision of Taiwan's development into a "green silicon island," the Council for Economic Planning and Development (CEPD) collaborated with other concerned government agencies to draw up the Challenge 2008 National Development Plan. This plan set out the framework and direction for carrying our political, financial and fiscal reforms and also mapped out four major themes and ten key projects for investment in Taiwan's future. It also made provisions for the introduction of supporting laws and regulations, the planning of funding sources, and the evaluation of performance results, as required for the achievement of its objectives. On the legal and regulatory fronts, after conducting consultations with all related government authorities, the CEPD identified 97 laws and administrative orders requiring enactment or amendment. These included 44 laws, of which 19 have already been enacted and 10 are under deliberation in the legislature, and 53 administrative orders, of which 47 have already been announced and put into effect (Chang, 2004).

2. Industrial Competition Policies

2.1. The Statute for Upgrading Industry

The Statute for Upgrading Industry is the most powerful industrial competition policy instrument Taiwan's government has applied to increase the competitiveness of the industries the government plans to support. There are three important facets to this statute: First, all the industries that are assigned by the government as the strategic industries (primarily the information industries), can have a five-year tax holiday (tax

free) or the tax on the investment can be waived. Second, there is a 5 to 20% tax waiver on businesses' investment costs for production automation or automation techniques. Third, the cost of business investment in R & D and employee training can enjoy as high as a 35% tax waiver. The tax incentives for strategic industries are believed to encourage companies to invest in the key, new, but risky industries that the government believes might be crucial or promising for Taiwan's future economic growth. Thus, this instrument helps the government to funnel economic resources into industries that the government is hoping to cultivate. The tax waiver benefits on informatization, R & D, and employee training are also expected to enhance the entire production capacity and human capital quality in Taiwan and to encourage innovation with new techniques, new products, and new inventions, which are thought to contribute to Taiwan's information economy (R. L. Chen, 2006).

3. Industrial Support Polices

3.1. Technology Development Program:

From 1979 to the present, Taiwan's government has employed the Technology Development Program to help develop new key products, industries, and production techniques. The purpose of this program is to help enterprises lower or even avoid the risk and cost of investment in R & D for new and uncertain products or technologies. Through government funding, Technology Development Programs authorize research institutions, universities, and industrial research groups to research and develop these new techniques, products, and technologies, and then through technique transfer, patent authorization, or industrial services, to diffuse these new products, techniques, or knowledge to relevant industries for production or application. The effects of Technology Development Programs have included driving industries to further R & D, inducing business investment in further production (for instance, it has been claimed that the

programs brought in 9.4 hundred millions dollars for R & D and production investment in 2004), or even establishing new industries or companies (R. L. Chen, 2006).

3.2. Industrial Technology Research Institute of Taiwan:

The Industrial Technology Research Institute of Taiwan (ITRI) was established in 1973 by the government. ITRI was delegated the responsibility for developing new industrial techniques, technologies, and also new products, and of diffusing them into industries for production or application. ITRI is still one of the main institutes which produce the most patents each year in Taiwan. According to the Taiwanese government's estimates, each dollar invested in ITRI can add 11 dollars of business value (or 2 dollars net profits). Furthermore, the technological professionals who were trained by ITRI and then transferred into the industries have already founded more than 55 companies, creating more than 2.2 million NT dollars of business value by the government's estimation (R. L. Chen, 2006).

3.3. National Applied Research Laboratory:

The National Applied Research Laboratory was established in 1984, based on the Euro-American's examples. The National Applied Research Laboratory was in charge to do more fundamental scientific academic research and to develop high tech products. It also helps industries in technological professional personnel training and transfers research results to industries for application (R. L. Chen, 2006).

3.4. Technological Personnel Training and Foster Program:

From the time that Executive Yuan announced the Science and Technology Development Program in 1979, the government started to guide the education and job training system to educate and train students according to the needs of domestic industries. With the same intention, in 1995, the Technology Personnel Training and Foster Program was announced. Its specific programs incorporated establishing a mechanism through which industry partners and academic institutes could cooperate in personnel training; authorizing research and business sectors to do the worker training;

encouraging academic researchers to participate in industries and in industrial research; improving the efficiency and effectiveness of the job training system, through policies such as establishing an effective evaluation system; increasing the invitation of overseas professionals to come to Taiwan to contribute their professional knowledge; and setting up a personnel database of overseas professionals and helping domestic IT companies to find fit employees through this system (Science and Technology Advisory Group of Executive Yuan, 2008).

3.5. National Development Fund:

The National Development Fund was set up in 1973 for the purpose of helping the new enterprises in those strategic industries assigned by the government to initiate their businesses. However, in order to obtain loans from this fund, except for the purpose of founding new companies in strategic industries, businesses also had to meet the policy prescriptions the government asked for such as using loans on business upgrading, production automation, business electronicalization, and new product development (Science and Technology Advisory Group of Executive Yuan, 2008).

3.6. Preferential Loans:

A very important source of financial support from the government for the strategic industries was the offering of preferential loans. Unlike other capitalist countries' that had private bank systems, Taiwan's bank system was controlled and owned by the government for a very long time until the 1990s. In the 1990s, the KMT government started to allow the establishment of new private banks, but the government still owns and controls the government-owned banks. These public banks have the very important responsibility of accomplishing the government's policy goals, especially the strategic industry policy and industrial upgrading policy. Therefore, under the government's supervision, the public banks offer a variety of preferential loans to industries, enterprises, or R &D activities that government is willing to support or

encourage. In addition to the preferential loans, the Taiwanese government also harnesses venture capital to help innovative industries and enterprises (J. H. Wang, 2003).

3.7. Venture Capital:

Venture capitalism has flourished in Taiwan and has played a major role in supporting Taiwan's information industry. In this process, the government was the catalyst. It began promoting venture capital funds to finance start-ups in 1983, at the instigation of K. T. Li, the statesman mentioned earlier who was behind the rise of Taiwan's high-tech industries in general (Li 1988). In cases where an outside agent developed a start-up, typically that agent was the government rather than a venture capitalist (in fact the government started one of Taiwan's earliest venture capital firms). Sometimes the government did this directly, as in its founding of Taiwan's two world-class, state-owned semiconductor foundries, UMC and TSMC. Usually the government supported indirectly, by providing start-ups with the finances, facilities, and access to de-bugged technologies that were necessary for them to grow (A. Amsden & W. W. Chu, 2003). Anther policy also included giving the information industries preferential treatment such as shorter observation time to be qualified to enter the stock market to collect funds (Chan, 2004)。

3.8. The Corporate Synergy Development Center:

The government also contributed to networking a Corporate Synergy Development Center (originally called the Core-Satellite Development Center). The idea, promoted by the Industrial Development Bureau of the Ministry of Economic Affairs, was to germinate a center-satellite factory system in appropriate Taiwan industries. The system was designed to strengthen small firms by incorporating them into the orbit of a large enterprise. It was hoped that the small firm would thereby face more stable demand so that it could concentrate on upgrading its operations. Better cooperation between the center and the satellite was also expected to raise the level of productivity and efficiency throughout the economy.

Both center and satellite received financial inducements from the government to cooperate. Satellites obtained technical assistance from the center related to just-in-time inventory management, cost rationalization, quality assurance, and other upgrading programs. Centers enjoyed opportunities to invest in promising start-ups, better performance on the part of their suppliers, and subsidized management-consulting fees to install management systems in their suppliers that were in their own interests to install in any case.

At first, the CSD focused on promoting center-satellite systems that were vertical. Vertical systems were of two types. In one, the center bought parts from the periphery. In the other, the periphery further processed inputs from the center (in-processing). Then in 1995, the IDB required the CSD to offer additional services to facilitate horizontal cooperation among different types of firms within an industry such as sharing marketing channels or at least sharing global market intelligence (as in the case of the IT industry's Marketing Intelligence Center). Thus a third type of system emerged-- the horizontal system.

The CSD helped to build, maintain and monitor a common C-S framework for each industry. It also helped to coordinate and upgrade technological capabilities, managerial expertise, and e-commerce for registered firms. Those firms participating in the program found assistance related to total quality management, total cost rationalization, and satellite quality assurance most helpful. By 2000, the CSD had registered 192 C-S systems that involved 3,115 firms (A. Amsden & W. W. Chu, 2003).

4. Industrial Infrastructure Policies

4.1. Science Parks:

As mentioned in the previous section, the establishment of Science Parks, especially the Hsinchu Science Park, was also an important policy contributing to Taiwan’s information economy. In 1980, the Hsinchu Science Park was established after

the model of the Silicon Valley in the U.S., in order to encourage information-intensive manufacturing to invest in production in Taiwan. IT companies in this park could enjoy tax rebates, technical support from the government, preferential interest rates for loans, and also subsidies for R & D costs, thus making it a site that attracted a considerable amount of domestic and also foreign investment from the high-tech industry (R. L. Chen, 2006). In addition to the policy benefits the government offered to encourage investment in the Hsinchu Science Park, the learning and networking effects from this geographic gathering have also been an important factor in the development of Taiwan's information economy (M. C. Tsai, 2005). Later, in 1997 and 2003, the government also built the second and the third Science Parks—the Tainan Science Park and the Taichung Science Park respectively, to expand the scope of Taiwan's information-intensive manufacturing.

4.2. National Information Infrastructure:

The National Information Infrastructure (NII) Plan was announced in 1997. According to this plan, information and Internet infrastructure would be the centers of the new economy, and the spirit of innovation would penetrate most of the activities in the information society, including economic, technological, educational, cultural, or social aspects. Its detailed plans included four objectives. The first was improving information infrastructure–copyright and electronic signature law, improving the safety of on-line transactions, increasing the Internet population, and increasing Internet construction. The second was constructing the electronic government. The third was promoting industrial electronicalization. The last was preventing problems caused by an information society, such as lowering the digital divide and also improving Internet content (Science and Technology Advisory Group of Executive Yuan, 2008).

Technology Policies

Technology policy has also been closely related to the construction of Taiwan's information economy. Before 1970, Taiwan's technology policy focused more on academic and scientific research considerations such as improving scientific education and strengthening scientific research. However, after 1970, under Chiang, Ching-Kuo's plan to utilize technology to help advance economic growth and development, Taiwan's technology policy started to align itself with the needs of industrial development (Chou, 1998) and also began to become a policy tool to support the information economy. Two representative technology policies are as follows:

1.1. Science and Technology Development Program:

The Science and Technology Development Program announced in 1979 was derived from the previous year's National Scientific Technique Conference. There were three primary goals of this program: applying technology to help economic development, advancing national welfare, and building an independent national defense system. Four industries were chosen as the technology development focus—information, automation, energy, and materials; the next year biological technique, photodiode, and another two industries were also added.

1.2. White Paper on Science and Technology:

In the late 1980s, Taiwan faced the threat of deindustrialization because of the rise of other NICs' participation in labor-intensive manufacturing. Thus, how to speed up Taiwan's industrial upgrading and restructure the industries to maintain a competitive advantage became the new goals of the new technology policies. In 1997, the fifth National Scientific Technique Conference announced the White Paper on Science and Technology, which assigned industries with high intersectoral linkages, high technology-intensiveness, highly value added, and low energy consuming as the ten strategic industries. These industries included telecommunication, information, consumer electronics, semiconductors, precise machinery, automation, aerospace, advanced

materials, specialty chemicals, pharmaceuticals, medical services, and pollution prevention. The detailed objectives of this White Paper outlined: increasing R & D input, improving human capital quality, enhancing universities' research capacity, promoting new technology research plans and national technology programs, developing and researching key techniques for industrial development, accelerating the technique transfer from research institutes to industries, and constructing a national information infrastructure. The overall goals of this White Paper were to develop Taiwan as an Asia Pacific research center, high-tech production center, and finally as a technology island and country (Chou, 1998).

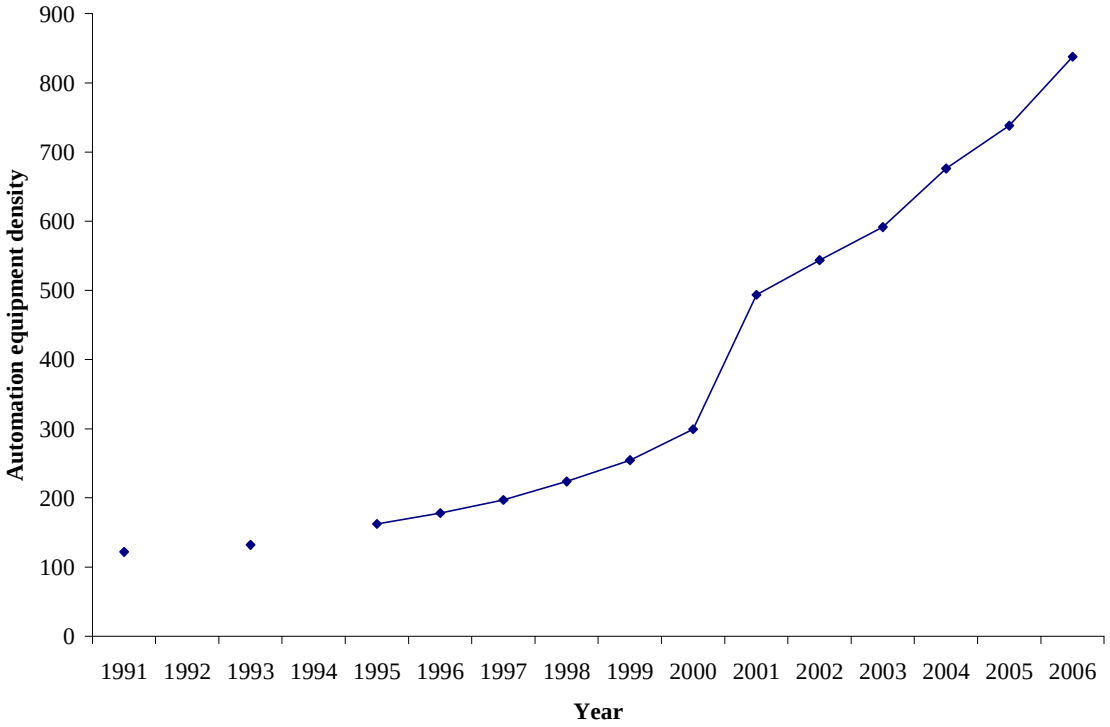
Industrial Automation & Electronic Business Policy

To accelerate industrial upgrading through rough production automation and IT application has also been a critical strategy of Taiwan's information economy policy. Two representative policies here are—the Industrial Automation & Electronic Business Program and the National Information & Communication Initiative.

1.1. Industrial Automation & Electronic Business Program:

Since 1980, Taiwan's government has continued to promote the Production Automation Ten Year Plan and the Industrial Automation Ten Year Plan, in order to assist industries to execute standardized production and to automate production lines in a planned way. In 1999, the Executive Yuan extended these original plans into the Industrial Automation & Electronic Business Program. The new plan, in addition to continuing to promote the automation of production, storage, delivery, and management, also chose a number of focal industries for which to set up electronic business management for their supply and demand chains' (*2004 Electronic business white paper in Taiwan*, 2005). In order to offer industries incentives to implement automation and electronic business, the government applied the Statute for Upgrading Industry to give

businesses preferential loans and tax rebates for purchasing automation equipment. Moreover, the government cooperated with research institutes and universities to assist industries in setting up standardized automation production processes (*2004 Electronic business white paper in Taiwan*, 2005). Figure 5 presents the rapidly growing trend of automation equipment density in industries[12].



Source: Department of Statistics, Ministry of Economic Affairs, R.O.C.

Figure 5. Automation equipment density

1.2. National Information & Communication Initiative Plan (NICI):

This NICI incorporated numerous programs. One of them, Industrial Electronization, planned to promote electronization for not only manufacturing and service industries but also for most industries in Taiwan and also for small and middle sized enterprises. For bigger enterprises, the NICI group helped to build up a complete information system which could manage every action and point in the business process

[12] Automation equipment density, according to the Department of Statistics, ministry of Economic Affairs, R.O.C. (2006), is measured by the sum of money of automation equipment (including hardware or software) divide by the total amount of workers employed in each year.

(*2004 Electronic business white paper in Taiwan*, 2005). Another plan—the Development Plan for Global Logistics in the Manufacturing Sector which was approved in December 2001 and based on the NICI Plan--listed e-industry as one of its main infrastructures. This plan is also based on an operation headquarter proposal found in the Challenge 2008: 6-Year National Development Plan. The plan aims to construct a sound industry e-business infrastructure that would bring about a highly efficient e-supply chain management network for a global logistics operation system. The plan is for these visions to be achieved through using a center-satellite systems strategy in e-industry and helping each operation headquarters build e-nerve center systems. There are two major directives under this plan. The first is researching the business model, operation model, and IT model of each operation headquarters, and the second is creating an e-Business Assessment Scheme for each enterprise (Industrial Development Bureau, Ministry of Economic Affairs, 2008).

1.3. The Challenge 2008 National Plan:

The Planning and Implementation for the challenge 2008 National Plan was a comprehensive program for Taiwan's informatization and economic growth. Among them, the e-Business project focused on helping industries construct an e-supply and e-demand chain management network, which can integrate and further control the flow of information, money, and goods. The industrial electronization plan projected to establish an informatized system of technology design to facilitate the sharing of technology design information and knowledge among high-tech industries (*2004 Electronic business white paper in Taiwan*, 2005).

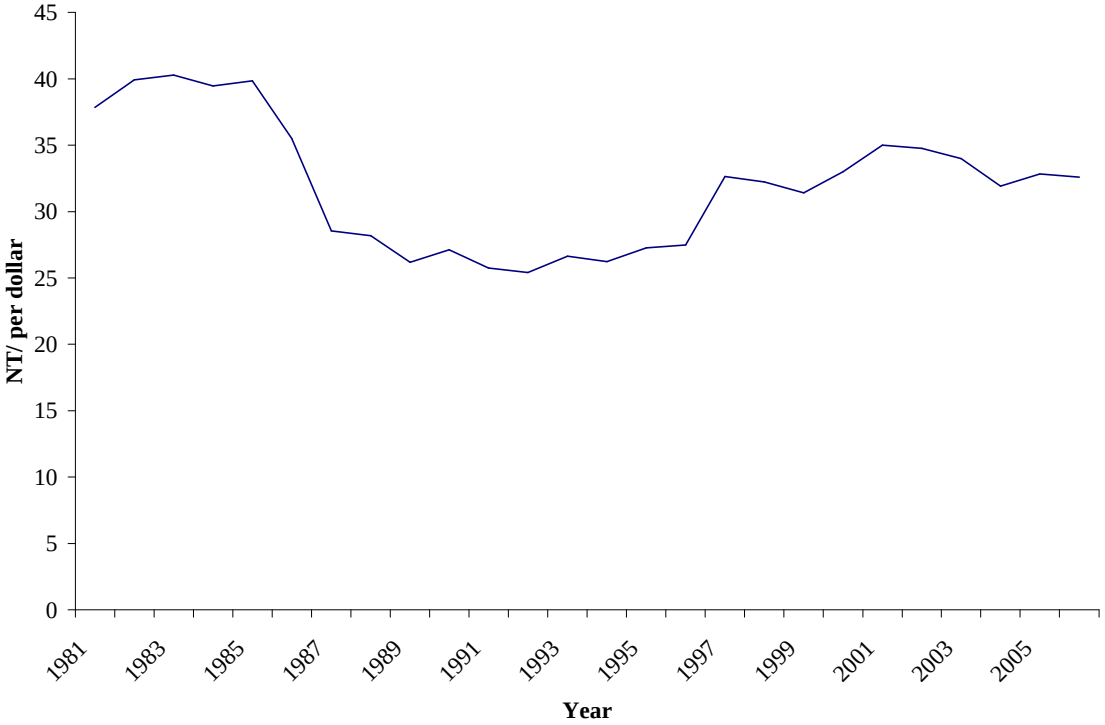
Other Policies for Information Economy

In addition to the industrial policy, technology policy, and industrial automation and electronic business policy, Taiwan's government has also employed other economic

or education policies to support its information industries, in order to lower their production costs or to increase their competitiveness.

Exchange Rate

Keeping a comparatively undervalued real exchange rate is also a powerful instrument that has helped the Taiwan government to spur its IT product exports. One estimate puts the magnitude of undervaluation for Taiwan at around 25 percent in the mid-1980s (Wade, 1990) (also see Figure 6). Over the 1980s, the exchange rate was fixed at close to NT$ 40=US$ 1. However, under pressure from the U.S. government, the NT exchange rate appreciated per dollar from NT $35 in 1986 to NT $29 in 1987 and then to NT $ 25 in 1992. After 1993, it devaluated again to NT $28 =US$ 1in 1997 and to 34.5 in 2002; it maintained the rate of around NT $30-$32 per US dollar from 2005 to 2008. The devaluation of NT at this period was because the value of the US dollar rose again as a result of America's economic prosperity. This devaluation helped spur Taiwanese IT companies' exports to the Euro-American markets.



Source: The Central Bank, R.O.C.

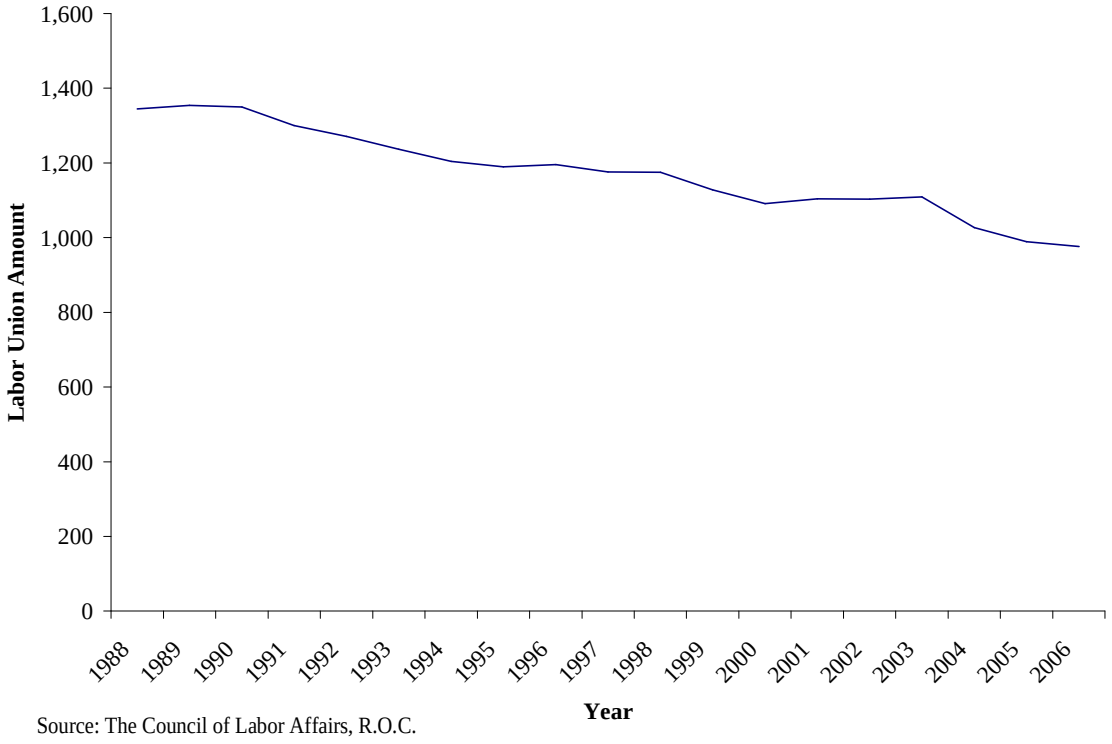
Figure 6. Exchange rate

Wage and Labor Policy

The wage policy was also an instrument that helped maintain the competiveness of Taiwan's domestic companies. The minimum wage was kept very low in order to maintain Taiwan's low labor cost advantage in international trade. With the exception of setting the minimum wage, the government did not intervene in the wage determination in the labor market; however, it still managed through suppressing labor unions and limiting labor movement to indirectly keep Taiwan's wage rate at a comparatively low level. Labor unions were tightly circumscribed. Most were based on the company rather than on the occupational category, with the exception of some countywide unions for specialized workers such as welders. Unions' financial resources were restricted by law, and the head of the union was paid by the company for which he worked. The right to strike was prohibited by martial law. All unions within a county were grouped into a county federation, tightly controlled by the KMT party. There have also been several inactive provincial associations of county federations, staffed by life-long party-appointed officials. The availability of private safety-nets, such as retail trade and family income-pooling, together with the long-standing shortage of many kinds of skills, have further reinforced the powerlessness of labor unions (Wade, 1990).

The Taiwanese government could practice this kind of labor control because the KMT government was the only dominant political power for a very long time. However, after the 1980's with the blooming of labor consciousness and the labor movement, it became harder for the government to continue to ignore worker benefits in favor of industrial advantage. In 1984, the government proposed the Labor Standards Law under pressure from both the U.S. government and from Taiwanese voters. In 1987, the government also established the Council of Labor Affairs to handle labor issues (N. C. Wang, 2002). Later, the minimum wage was raised in the first half of the 1990s, about 6% to 10%, but from 1998 to 2006, the government did not raise the minimum wage due

to the fact that Taiwan was experiencing low economic growth compared to the previous years (The Council of Labor Affairs, R.O.C., 2008). Figure 7 demonstrates a gradual declining trend of labor unions in Taiwan after 1990, which was believed to be highly related to the globalization trend—also to the emigration of Taiwanese manufacturing and the strategies to divide the labor unity by the political power.



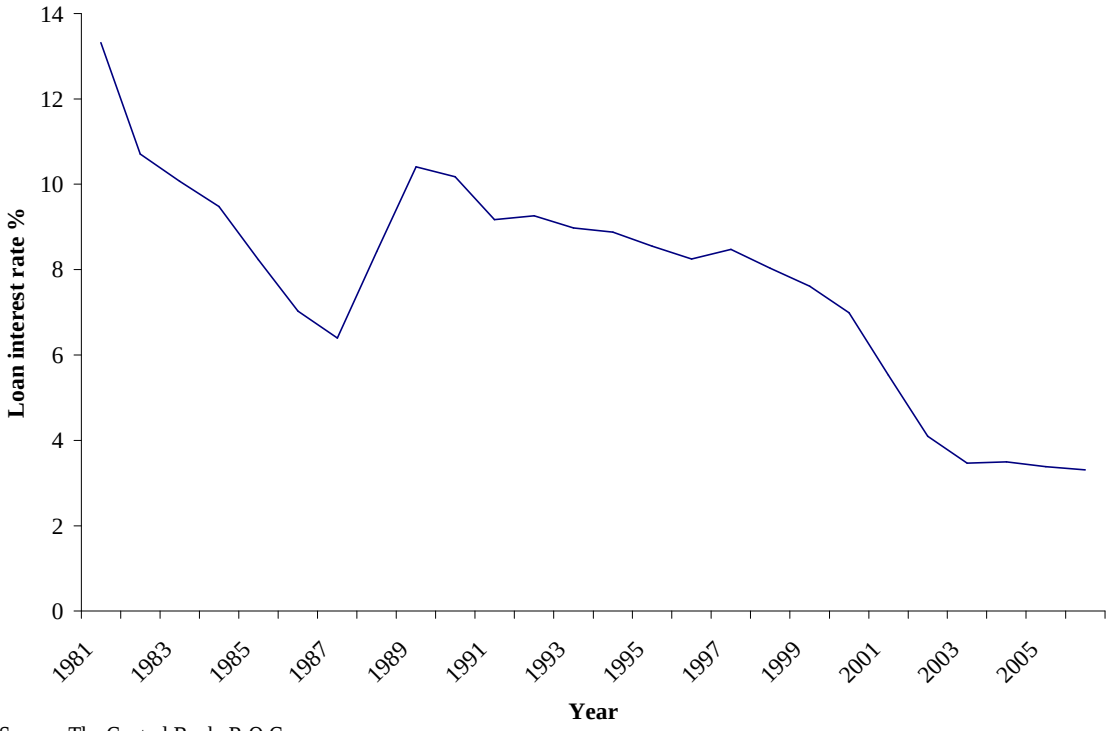
Source: The Council of Labor Affairs, R.O.C.

Figure 7. Labor unions

Interest Rates

Interest rates are believed to be very closely related to investment, saving, industrial development, and certainly economic growth. Taiwan was one of the first, if not the first developing country to adopt a high real interest rate policy. The real rate on savings deposits was 6 percent or more in virtually all the years between 1955 and 1980, except for the high inflation years of 1973-74 and 1979-80 when it turned negative. It averaged about 9 percent between 1955 and 1964, and about 8 percent between 1965 and

1972. The high interest rate policy came in response to the hyperinflation of 1946-50, when prices rose by thousands of percent (Wade, 1990). Taiwan's government retained this high interest rate policy for around thirty years, which contributed to Taiwan's savings and economic growth. However, after 1984 (also see Figure 8), the Taiwanese government began to push for economic liberalization and internationalization, which included a market-determined interest rate. Nominal interest rates were maintained at around 8 percent in the 1980s and 1990s; however, it dropped by about 7 percent to 3.31 percent in 2006, representing a zero or even negative interest rate age (The Central Bank of the Republic of China, 2008).



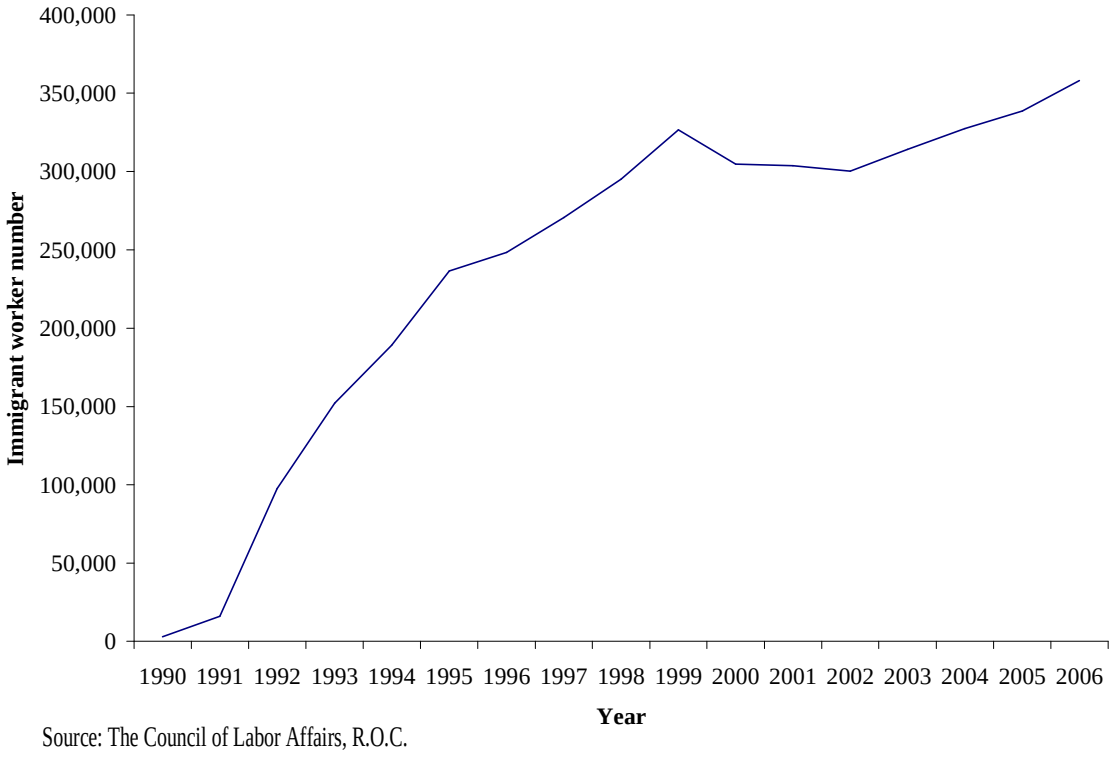
Source: The Central Bank, R.O.C.

Figure 8. Loan interest rate

Immigrant Worker Policy

Another important and relevant policy was the introduction of immigrant workers for the purpose of lowering firms' labor costs. In 1991, Taiwan's government announced the opening of the borders for immigrant workers to come to Taiwan to work in order to

solve the problems of insufficient workers and increasingly higher labor costs, which resulted in the moving out of Taiwanese firms and the creation of a hollowing out of industries. Immigrant workers are believed to have a very high replacement effect on low- skilled level (labor intensive) workers, especially the senior ones, but they also have a complementary effect on higher level professional workers (Q. L. Tsai, 1999). Figure 9 presents the increasing trend of the amount of Taiwan's immigrant workers.



Source: The Council of Labor Affairs, R.O.C.

Figure 9. Immigrant workers

Education and Human Capital Policy

The high education level and good quality of Taiwan's labor also contributed considerably to the development of Taiwan's information economy. The quality of human capital and the technological R & D capacity of Taiwan is claimed to be second only to Japan in Asia (F.-Y. Lin & Liu, 2002). According to the 2008 Information Technology Industry Competitiveness Index of the Economic Intelligence Unit (EIU) (2008), Taiwan's R & D environment ranked first and human capital ranked seventh in

the world. Looking back on Taiwan's human capital policy, we can find that it was pretty closely related to or even led by the government's industrial or economic objectives. Along with the industrial transformation, Taiwan's human capital policy can be grouped into five different phases.

First, in the 1950s, in order to be in alignment with the economic policy, the human capital policy focused on Import Substitution, which planned to promote Taiwan's domestic light industries in order to avoid importing too many basic commodities from abroad. Taiwan's government decided to require six years of compulsory education in order to universalize basic education so that there would be sufficient labor of a certain quality for the domestic light labor-intensive industries.

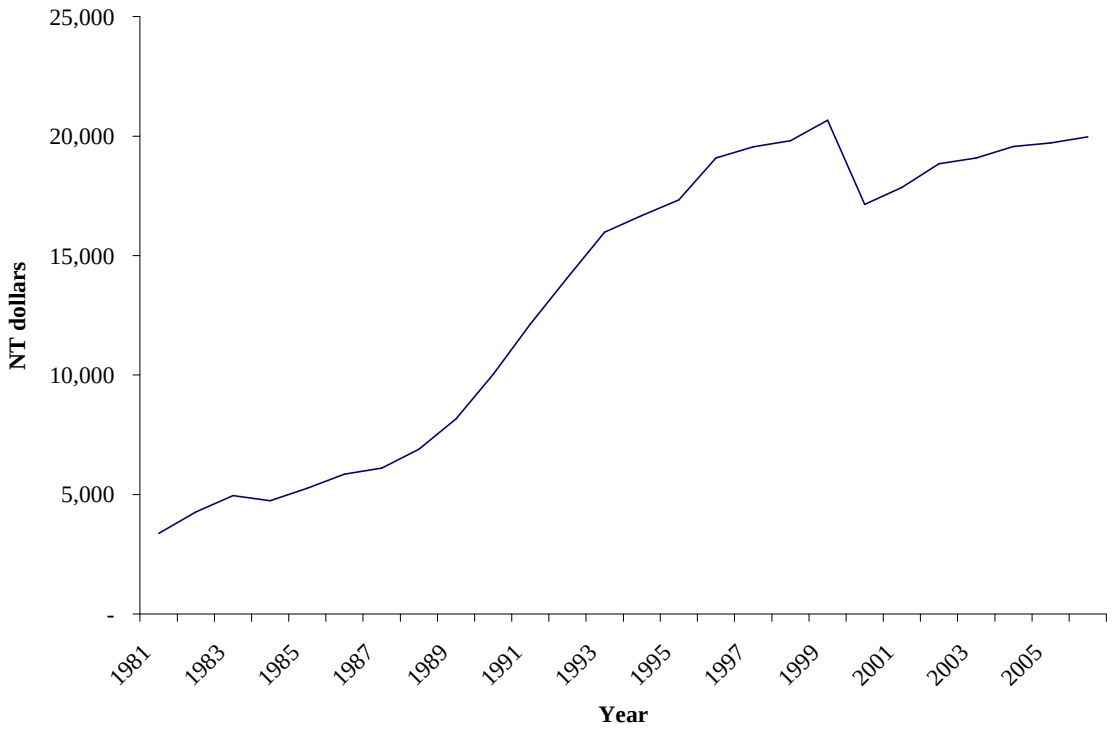
In the second phase during the 1960s, Taiwan started to develop an orientation toward expanding exports. In order to solve the problem that industries had already upgraded and needed higher quality workers, the government extended the compulsory education to nine years, and in the meantime developed vocational schools and encouraged the founding of junior colleges, to enhance the quality of human capital and increase the labor supply for industrial development (Day, 2005).

In the 1970s, the Taiwanese government was hoping to upgrade Taiwan's industries to be more capital intensive with more middle and higher stream heavy industries such as petrifaction, but later turned to machinery, information and electronics, due to the oil crisis. In order to face the problem of the surging needs for technicians and professionals, the government started to advocate vocational skill training education, technological education, and in this stage, Taiwan also established the vocational education system.

In the 1980s, Taiwan's economy faced another round of industrial upgrading pressure—transforming it from a labor intensive to an information intensive economy. To solve the related human capital problem, the education policy began to focus on training technological professionals. The government executed industrial personnel training

programs and also established numerous institutes of technology (having the same four year education program as universities and having the same rank). It also offered further education opportunities for vocational school graduates, hoping through these strategies to increase the supply of Taiwan's high-level technology personnel.

In the 1990s, Taiwan's government adopted an open policy for domestic investment in China, and thus Taiwan's labor intensive industries started the second round of immigration and thus further pushed toward the completeness of Taiwan's industrial transformation. By the 1990s, Taiwan's industries had almost transformed to being completely information intensive and, therefore, needed a great number of professional and technological personnel. Consequently, the government founded and encouraged the establishment of universities. The number of universities surged in a very short time after 1990. In addition to this, Taiwan's government also strongly pushed for the invitation and training of professional and technological personnel and also arranged lifelong learning plans to place stress on workers' re-training and further education (Day, 2005). Figure 10 shows the uneven but generally growing trend of the Taiwan government's investment in education per citizen.



Source: Ministry of Education, Department of Statistics, R.O.C.

Figure 10. Government's education investment per citizen

DIFFERENT FORCES IN THE PROCESS OF TAIWAN'S INFORMATIZATION

In the process of informatization of Taiwan's economy, various social forces played different roles in influencing this development. The main actors in this process consisted of the state and government elite (including the political leader, Chiang, Ching-Kuo), the technological elite, the industrial elite, the small and middle-sized enterprises, as well as the foreign capital and the international political and economic situations.

State and Government Elite

One of the most important reasons why Taiwan's model was able to succeed in the global information market was because the state successfully led the direction of industrial development. On the one hand, Taiwan improved its productivity and learned advanced techniques and skills by participating in international markets and cooperating

with large, transnational companies. On the other hand, Taiwan continued its industrial upgrading and developing of new industries by following the lead of the government's industrial and related policies, all of which we discussed in the last section. Therefore, the state did have a weighty influence in the development of Taiwan's information economy. However, the power of the state in deciding or influencing the information industry's development has changed and may even be considered to have weakened over time. We can roughly divide the government's involvement into three stages.

In the first stage, during the 60s and 70s, the government bureaucrats had almost full power in directing the development of Taiwan's information economy under the authorization and trust of Taiwan's top political leadership[13]. While they held strong political and military power, the KMT elites had no intimate ties with the dominant social classes. The full-blown state bureaucracy, on the other hand, penetrated its society down to the residential neighborhoods, village, schools, and larger work units. There were no native or foreign forces in the society which were strong enough to manipulate the formulation of or resist the execution of state policies. The only force outside the state apparatus that could exert significant weight upon the policy-making was that of the American advisers. Nevertheless, the economic policy makers still maintained certain links with leading businessmen through a couple of informal channels such as the Chinese National Association of Industry and Commerce (Pang, 1992). Industrial policy-making in this stage took place within a narrow coalition which included, at the core, the technocrats and ministers of the central economic bureaucracy plus the senior managers of public enterprises and public research organizations, with Nationalist party leaders and military leaders having veto power. At the edges of this process were the selected managers of large foreign and domestic firms. Small businesspeople, workers, and

[13] After the KMT had withdrawn from mainland China, the party's leader had recognized that economic affairs should be handled by real economic experts, not politicians, and thus decided to give the economic bureaucrats more power and authority to determine economic and industrial policies (Tuan, 2000).

peasants were excluded from participating in the establishment of economic policy (Wade, 1990).

In the second stage, spanning the 1980s, some information sectors had been built, and more technological elites had been incorporated into the operation and decision-making processes as consultants, sharing the power with bureaucrat elites.

In the third phase, by the end of the 1980s, Taiwan's political and economic situation had changed dramatically and had become more liberal. Industrial forces had progressively more ability to influence the policy making through lobbying the Legislative Yuan and law makers. Especially after the 1990s, the economic scope and power of these IT companies had become too large to be dismissed. The expansion of the private sector and the emergence of big enterprises had gradually undercut the autonomy of the KMT state in formulating and executing economic policy. By this stage, the industrial elites had become more crucial or even determinant in deciding the direction of the development of the information industry (Tuan, 2000).

Nevertheless, generally speaking, the local capitalists did not play a decisive role in the state's economic policymaking. The state consistently acted relatively autonomously from the new dominant class. Unlike the examples of Japan and Korea, state business relations were relatively distant and cool in Taiwan (Pang, 1992). Exchanges between the state and the bourgeoisie were not very frequent. No local capitalist was recruited to be a member of the Executive Yuan Council or the economic bureaucracy until 1981. The economic policy makers and bureaucrats usually did not consult social groups prior to policy shifts. They analyzed problems and options and then devised incentives, based on what they believed the local and transnational capitalists would respond to (Gold, 1986: 127). Although in some cases the local capitalists were solicited for opinions, the economic policy makers still played the role of final judge.

Now we want to go back to overview the state's role in Taiwan's industrial progress. Before the 1970s, the Kuomintang (KMT) state was given American assistance

and had more range to determine its economic relations with the outside world. The KMT state, on the one hand, dominated the economy and accounted for a sizable portion of the industrial production. On the other hand, it fostered the supply of consumer goods through various measures of encouragement and protection of local capitalists. The result was that when U.S. aid stopped and Taiwan had to incorporate itself into the world capitalist system, it had already developed a prospering local bourgeoisie and a strong state which played the most significant role among the three partners of the "triple alliance" (Wade, 1990, p. 259). At this time, the internal structuring of Taiwan's government, the KMT state, for economic policymaking was composed of an impregnable top political leadership and a group of competent economic policy makers assisted by a company of hardworking bureaucrats. It employed a variety of measures concerning foreign exchange and trade to extract agricultural surplus, to guide consumption patterns, to conserve foreign exchange, and to protect domestic firms so as to promote import substitution in light industry. Although it progressively loosened up its control over the economy to include the operation of market forces, it did not just set price controls. It still intervened directly in the economy by channeling funds for investment, devising indicative plans, improving the physical and psychological investment climate, and guiding Taiwan's incorporation into the world capitalist system (Gold, 1986: 122). 256-2

As Onis (1991) pointed out, within the Taiwanese bureaucracy, a pilot agency plays a key role in policy formulation and implementation. Close institutionalized links are established between the elite bureaucracy and private businesses for consultation and cooperation. The organizational and institutional links between the bureaucratic elites and major private sector firms are crucial in generating a consensus on goals, as well as in exchanging information, both of which constitute essential components of the process of policy formulation and implementation. Yet another crucial component is a political system in which the bureaucracy is given sufficient scope to take initiatives effectively.

The politicians "reign" while the bureaucrats "rule." The objective of the political elite is to legitimize the actions of the elite bureaucratic agencies and make room for the latter's actions (Onis, 1991, p. 111).

Focusing more specifically on information industry policies, for example, the government's determining and operating system in these areas was centered on the Ministry of Economic Affairs, which was authorized by the president. Above the Ministry of Economic Affairs was the Technical Advisory Committee, which was responsible for giving suggestions to guide Taiwan's policies concerning the information industry. In addition, under the Ministry of Economic Affairs, there were the Industrial Development Bureau, the Bureau of Foreign Trade, the National Science Council, and the Industrial Technology Research Institute, which together helped to carry out policies related to the information economy. The assistance that the government bureaucrats provided for information industries has been mainly twofold: to assist the information industries' growth through economic and industrial policies; and to let Taiwanese companies learn advanced skills and technologies by networking or connecting international and domestic companies through foreign investment or technical cooperation (Tuan, 2000).

The personality and will of Taiwan's political leader in the early stages of the development of the information economy was a much weightier determinant than in the later stages. As mentioned earlier, in the 1970s Taiwan faced a series of political and economic blows such as its withdrawal from the United Nations in 1971, the breaking of diplomatic relation with the U.S. in 1972, and the oil crisis of 1973. The successor and also the son of Taiwan's dictator (Chiang, Kai-Shek,), Chiang, Ching-Kuo, faced a very harsh situation and had to struggle to maintain his political power and the legitimacy of his government. He needed to maintain economic stability and growth to win people's support for his governance. From his staff members' advice, he quickly came to the conclusion that promoting technology as a pillar of the economy, upgrading Taiwan's

manufacturing industries, and developing information industries were feasible ways to reinforce Taiwan's economy and help the island recover from its international, political and economic hardships. Chiang, Ching-Kuo's experience living in Russia as a socialist also led him to deeply believe in the state's power, plan, and policy as the way to lead economic development[14]. Thus, with his support, Taiwan's integrated circuit industries, computer industries, and many other IT industries were built up and many plans for developing the information industry were carried out. He authorized a group of competent economic bureaucrats he trusted to implement his "planned economy" programs and his ideas for Taiwan's economic growth (W.-H. Tsai, 2005, pp. 92-94). Therefore, when the international context of U.S.-Japan competition induced IT production deconstruction and the trend towards outsourcing, Taiwan caught this historical opportunity at exactly the right time. The fact that Taiwan was able to take advantage of this opportunity was largely due to the political leader's intense sense of urgency about the country's survival and economic growth and his investment of a huge amount of government money in the development of the information industry.

In sum, in the course of Taiwan's economic transformation, the state, especially in the KMT age, acted as a relatively autonomous apparatus pursuing developmental goals defined by itself rather than as an instrument of domination manipulated by certain social classes or groups.

The Technological Elite

When entering the high-tech sphere, the government bureaucrats can play only a supporting role and the technological elite become the main players. In Taiwan's

[14] Socialism and communism was popular in China since the 1920s and in 1925, Chiang, Ching-Kuo went to Russia to study communism in Sun Yat-sen University in Russia and also joined the Russia Communist Party. He stayed in Russia for twelve years total and the socialist thoughts became strongly rooted in his thinking (Wikipedia, 2009).

information economy development, the technological elites have consisted of overseas technological experts and domestic experts. The overseas technological experts were largely overseas Taiwanese technological professionals with whom the KMT government officials continued to maintain close connections due to the high respect the KMT government had for these overseas Taiwanese technological elites. These connections became a crucial contributor to the planning and growth of Taiwan's information economy later on in the 1980s. The KMT government invited overseas IT experts to form a Technical Advisory Committee, responsible for giving policy suggestions for Taiwan's information economy development. The domestic technological elites were mainly the professional employees of the Electronics Research Laboratories in ITRI. They were the main force used to execute the policies upon which the government and the Technical Advisory Committee had decided. Some of them were later sent to the U.S. by the government to acquire more IT knowledge, and many of them later on became the founders, CEOs, or senior managers of Taiwanese IT companies as the government implemented its plans for technique transfer to the industries (W.-H. Tsai, 2005; Tuan, 2000).

Industrial Elite

The industrial elite obtained the decisive power to guide the direction of information economic development after 1988 when the main planner of Taiwan's early information economy development, K. T. Lee, retired from the position of government administrator. Along with Lee's retirement, the importance of the Technical Advisory Committee also waned. The other landmark event in the industrial elites' takeover of economic power was in 1993, when the government proposed a new plan for establishing a new advanced technology semiconductor company but confronted severe opposition from existing semiconductor companies because of potential competitive relationships.

The result of this controversy turned out to be the victory of the industrial elite—the Legislative Tuan turned down the Executive Yuan's budget request under pressure from Taiwan's semiconductor industry. After that, the industrial elites and market considerations replaced the government elites as the main force deciding the direction of the development of Taiwan's information economy (W.-H. Tsai, 2005; Tuan, 2000).

The industrial elites consist mainly of two groups in Taiwanese society: the original technological elites and the professionals/managers from foreign or transnational IT companies. The latter now have become the majority of Taiwan's industrial elites. It can be found that these industrial elites usually share common backgrounds or social networking. First, many of them were from ITRI. Second, many of them graduated from Taiwan University, Chiao Tung University, or Tsing Hua University, the three main IT research universities in Taiwan. Third, most of them have similar social networking experiences through working in the Hsinchu Science Park. Fourth, many of them have connections with professionals (particularly the Taiwanese IT professionals) in Silicon Valley that they maintain in order to stay updated on technique and advanced knowledge (W.-H. Tsai, 2005; Tuan, 2000).

Small and Medium Enterprises

The small and medium enterprises, even though they did not have as much power as government, technological, and industrial elites in influencing Taiwan's information economy development, actually have contributed significantly to Taiwan's information economy and also mark an important characteristic which has distinguished Taiwan from other information economy systems.

Taiwan's information industries, as mentioned earlier, consist of a complicated network of corporate synergy, which incorporates large IT companies as well as small and medium ones. The large Taiwanese IT companies are mainly the ones that can

receive outsourcing contracts from international IT brands. They buy parts, let periphery companies further process inputs (in-processing) on their products, or subcontract their production to the periphery companies when they cannot handle the production in rush seasons. Each large IT company has several cooperative companies, and their cooperative companies also have sub-cooperative companies. These sub-cooperative companies might also have relationships with other large IT companies. All the relationships among big, medium, and small IT companies make up a complex and delicate network, which covers the complete process of IT production from the upstream to middle stream and then to downstream production (T. J. Chen & Ku, 1995; Gong, 2005).

Although these small and medium enterprises have more difficulty building up their own brands and marketing channels and can only earn meager profits by doing outsourcing for transnational companies, this delicate network of cooperation enables the whole of Taiwan's information product production to be highly flexible, competitive, energetic, variable, efficient, and powerful (T. J. Chen & Ku, 1995; Hsia, 2003; Hsu, 1999).

Transnational Capital and the Global Political and Economic context

Taiwan's information economy development has been subject to the influence of international political or economic context and power, especially the political and economic influence of the U.S. and the development and framework of world trade, global sourcing, and the global market. Without the global sourcing trend that started in the 1960s and commenced by transnational corporations looking for cheaper labor and production sites to lower production cost, Taiwan would not have had the opportunity to become a major exporter and to successfully cultivate its information industries and economy (Chou, 1998). Moreover, as a worldwide phenomenon, job redistribution has extended beyond national borders. The increasing capacity and standardization of

national and international telecommunication networks can support geographically-distributed labor division.

In the global labor division age, most transnational corporations establish their headquarters which hire many professionals and white-collar workers in industrialized countries; while at the same time, they export an incredible number of manual jobs to developing countries (Burris, 1999). For instance, the use of ICTs has enabled many communication industries in the First World to export their studios and factories to the Third World, where the average wage of the workforce is relatively low (Sussman & Lent, 1998). Castells (1996, pp. 265) described an example where the introduction of ICTs in the garment industry has led to a "bipolar labor force" on a global scale: the high-skilled designers and telecommunicating sales managers usually work in American cities, while the low-skilled and low-paid manufacturing workers usually locate in offshore sweatshops or rural areas in the First World. Thus, Sussman and Lent (1998) asserted a new international division of labor sharing a production platform but dispersed into segmented zones of industrial, semi-industrial, and Third World societies. This geographical integration of labor processes, especially in such high tech industries as electronics and communication, represents the latest stage in the accumulation and flow of capital on a global scale. Thus, as Kung (2005) pointed out, in this trend of global labor division, by doing outsourcing for the centric developed countries, Taiwan established its information economy and industries as the semi-periphery of the world production system.

Within the country, the goals formulated specifically in terms of growth and global competitiveness are rendered concrete by comparison with external reference economies, especially the economies of the U.S. and Japan, which have provided the state elites with models and development tracks for emulation, all of which shaped the face of Taiwan's information economy. Now we want to take a chronological look at the global political economic influence on Taiwan.

Before the 1970s, the most important feature of the wider political-economic environment within which Taiwan's economy evolved was a particular international geo-political context dominated by the United States. Taiwan was incorporated into the American hegemonic system for the purpose of containing the communist expansion soon after the outbreak of the Korean War in June, 1950, far earlier than its incorporation into the world capitalist system in the mid-1960s. For the entire decade of the 1950s and the first half of the 1960s, Taiwan was cocooned within American hegemony both geopolitically and economically. One of the main effects of this situation on Taiwan's economic transformation was, of course, the enormous U.S. aid to the island. It not only helped Taiwan alleviate its defense burden, balance the government budget, arrest inflation, and accumulate capital, but it also enhanced the confidence and willingness of investors to invest in the island. Another effect of this particular geo-political context on Taiwan's economic transformation was the influence of the American advisors on the KMT state's economic policy-making. The U.S. AID Mission to China played a weighty role in Taiwan's earlier development as it controlled resources that were critical to the KMT state, (Pang, 1992).

The second noticeable feature of the wider political-economic environment was the favorable timing of the world economy. U.S. aid had insulated Taiwan's economy from external forces during the 1950s. American financial and commodity assistance alleviated the necessity for Taiwan to rush into the capitalist world system. In the meantime, there was little TNC interest in the island. By the early 1960s, however, the market in the advanced industrial societies, especially in the United States, after having experienced high growth, increase of wage rates, and the loss of competitiveness in labor-intensive manufactured goods, was readily accessible to manufactured exports from the LDCs. The switch of the KMT state's development strategy from import substitution to export expansion and its efforts to improve Taiwan's investment climate meshed with this favorable timing somewhat by coincidence. The product cycle brought foreign capital

from Japan and the U.S. to the island. The timely arrival of this foreign private capital made up for the phasing out of U.S. aid. All the while, the CCP was obsessed with the Cultural Revolution on the mainland. Taiwan's export-led industrialization thus started in a good external environment. The favorable international economic situation lasted for about a decade. Facilitated by the prosperous world economy and enjoying preferential tariff rates in American markets, Taiwan's foreign trade and light industries that manufactured consumer goods grew rapidly and steadily. The boom of trade brought about unprecedented prosperity to the island but also brought in the influence of other economies, especially tile influence of the two major trading partners, namely, the United States and Japan. As a result, the involvement in the world economy deepened Taiwan's trade dependency and exposed Taiwan to the competition with other countries in the international market. At the same time, the change of the global political situation, particularly the change of U .S. diplomatic policy, constituted another major factor influencing the KMT state's development strategies. From the early 1970s onward, the KMT state's economic policy-making, to a certain degree, has actually been a response to the challenges from the international political-economic environment (Pang, 1992).

Taiwan first initiated its information industry at a time when the global IT industry began to deconstruct its IT production due to the severe competition between Japan and the U.S. IT companies. They divided and moved out the labor-intensive sectors or industries, such as IC packaging, to cheaper labor sites for enhancing the price competitiveness. Taiwan and other East Asian NICs were ready and more qualified due to their years of excellent experience and ability in manufacturing, and, consequently, successfully attracted U.S. and Japanese IT companies by their cheap and quality labor (W.-H. Tsai, 2005).

In the 1970s, several severe politically-driven economic challenges from the international environment changed Taiwan’s economic development track. These challenges included the oil crisis, coupled with the intensified competition from other

LDCs in the international market and the loss of diplomatic relations with the United States. It was these international events that brought the KMT state to revise its economic plan to pay more attention to information-intensive industries (Pang, 1992).

In the 1980s, the rapid trend towards globalization and the increasing pressure from the U.S. government to liberalize Taiwan's market made it harder for the government to apply economic or industrial policies to increase Taiwanese enterprises' competitiveness. By this time, most of the policy instruments of the developmental state-protections or incentives had been more marginalized (Wade, 1990).

In 1982, IBM started to sell low price personal computers (PCs) and adopted an open system for computer parts, which gave other countries the opportunity to get involved in the production of computer parts (M. S. Chen, 2005). Under this opportunity, Taiwan's government kept pushing information and technique-intensive industries as the industrial development focus (W.-H. Tsai, 2005). By the end of the 1980s, the price of PCs was continuing to drop, the international big IT brands were less and less able to produce IT products in their homelands due to the much higher labor cost, and Taiwan's role in IT production in the global market consequently had become more and more irreplaceable.

Entering the 1990s, the trade relationship between Taiwan and China had grown substantially; most labor intensive and also some lower-level skilled electronics and electronic machinery industries were moving from Taiwan to China. The loss of these industries made Taiwan encounter the problem of economic stagnation and industrial hollow, but luckily, to punish Japan for dumping memory, the U.S. taxed the import of Japanese PCs with a punishment tax, which gave the Taiwanese IT companies great opportunities to win over the U.S. big brands' outsourcing orders, making the production of PCs the new pillar of Taiwan's economy at this time.

Following this, the U.S. government under President Clinton pushed the growth of information infrastructure, creating a greater demand for computers and Internet

products, thus reviving IC industries. Under these U.S. policies, Taiwanese IT companies advanced to a more crucial position in the global IT production network through producing OEM and ODM for the U.S. IT name brands, which formed a global production chain of design, manufacturing, and also marketing IT products (M. S. Chen, 2005). Thus, in this stage, Taiwanese IT companies have become more and more global in their production and production locations. The major factory locations of Taiwanese IT companies abroad includes not only the south-east Asia countries and China (especially in the last two decades), but also incorporate sites near North America and Europe such as Mexico and Scotland.

In the 1990s, the Japanese yen appreciated to a very high extent, disadvantaging the Japanese IT brands' competitiveness, so Japanese IT companies started to speed the emigration of their domestic production and also increased their cooperation with Taiwan to extend to the production of crucial IT parts, which gave Taiwanese IT industries a perfect chance to upgrade the industry again for production of key parts. Following the industry upgrading of Taiwan's IT industries after 1990s, Taiwan thus became the biggest production site of IT hardware products in the world (Hsia, 2003). The products that international brands purchase has changed from lower level parts or products to semi-finished PCs, laptops, liquid crystal display screens, and other higher level products.

Entering the 2000s, due to the increasing emigration of mature IT industries from Taiwan to China, the Taiwanese government has continued to make progress on higher technology or new IT production fields such as IC design (becoming among the first two or three countries in IC design) and biotechnology or nano-scale technology in order to avoid the industrial hollow problem (M. S. Chen, 2005). In addition, Taiwan still dominates in the production of laptops, motherboards, LCDs, monitors, and IC outsourcing and is quite competitive in desktop, server, CD-ROM drive, and also digital camera production. The world's information industry recession in 2001-2003 hit Taiwan's economy badly, and the island had its first period of negative economic growth

(-2%) in its history, which also revealed that Taiwan's economy has been deeply connected to or even determined by the situation of the world's information economy.

The Middle Class and the Workers

The middle class and the workers showed very little influence in the policy making for information development, although they definitely were important participants and also contributors to Taiwan's information economy growth. The middle class and the workers' strength showed only after the 1980s. The emergence of social movements for consumerism, environmental conservation, and the labor movement since the early 1980s followed the growth of the middle class. The enactment of the Labor Standard Law reflected the increasing influence of the workers. Consequently, the rise of various social forces in Taiwan undermined the KMT state's character as a corporate actor and made it more like an arena of social conflict when deciding economic or information economic policies (Pang, 1992).

CONCLUSION

This chapter first reviewed Taiwan's economic and industrial history and described the transformation of Taiwan's economic production models, which shifted from agriculture (1945-1960), to labor-intensive manufacturing (1961-1972), to heavy chemical industries (1973-1983), and finally to information-intensive industries (1984-the present). This section also reviewed the political and economic contexts in which these economic transformations took place.

The next two sections presented the developmental history of Taiwan's information economy, which gave a comprehensive view of how Taiwan's information economy was developed and what kinds of social, political, and economic forces interacted and functioned in this process. This section grouped this process into three

different stages by the defining characteristics of the information economy in different times: the initiation stage by foreign capital (1954-1984), the stage of being incorporated into the global production system (1985-1992), and the stage of global production and extension (1993-the present). Generally speaking, foreign capital played the most important role in the first half of the first stage— the initiation stage by foreign capital (1954-1984), but in the second half, the government stepped in and led the information economy's development toward the purpose of political and economic growth. However, after the late 1980s, the government's power was gradually replaced by the industry's as Taiwan's democracy developed and also as the industries themselves became large in scope and economically powerful. However, in all of these stages, the international political economy, the international IT market, and also the transnational IT name brands always played contextual and determinant roles, circumscribing and determining Taiwan's information industrial development. In addition, goals formulated specifically in terms of growth and competitiveness was rendered concrete by comparison with external reference economies, especially those of the U.S. and Japan, which provided the state elites with models for emulation.

The fourth section focused more on the state, exploring what kinds of policy instruments the government employed to help encourage Taiwan's information development and maintain its growth. In addition to the most important instrument—the industrial policies (including industrial development policy, industrial competition policy, industrial support policy, and industrial infrastructure policy), Taiwan's government also utilized technology policy, exchange rates, interest rates, wage and labor policy, immigrant policy, and also education and human capital policy to help pursue the expansion of Taiwan's information economy.

The final section identified and also summarized different social forces' functions in Taiwan's information economy development. In these processes, government and political leaders, technological elites, industrial elites, small and medium enterprises,

transnational capital, the international political and economic powers and also the international context, all had very significant effects. However, other social groups such as labor unions or other social forces had comparatively little power in influencing the development of Taiwan's information economy.

In summary, Taiwan's information economy has been successful due to five main reasons: policy, financial, and technical support from the state (Amsden, 1985; Wade, 1990), economics of scale production (through the model of global outsourcing) (A. Amsden & W. W. Chu, 2003), the learning effects from geographic gathering of companies such as can be found at the Hsinchu Science Park, the transnational technical networking and cooperation with transnational IT name brands, and the corporate synergy network among Taiwan's large, medium, and small IT enterprises (this will be discussed in later sections). Other important reasons also include the high quality of Taiwan's human capital and the government's investment in the information and telecommunication infrastructures.

Overall speaking, different from the information economy development models of developed countries which most information society studies address, the development of information economy in a NIC such as Taiwan, government, instead of market logic, played the most considerable role in shaping the developmental direction that Taiwan would take to transform from labor intensive manufacturing toward an information-intensive economy. Moreover, the state also contributed significantly to upgrading Taiwan's information industries from labor -intensive information industries such as IC packages (the age dominated by foreign capital) to a real information economy, which applies more and higher level production knowledge and information. Unlike many information society studies, which often stress the determining power of information technology and of information but overlook the importance of the long existing political economic reasons such as the state's choices and policies, industrial transformation, and

also globalization as well as international political economic development and structure, this dissertation, by using Taiwan as an example, points out that these are also among the most important factors shaping a NIC, Taiwan's information economy.

Chapter 4: The Information Economy and Occupational Transformation

INFORMATION ECONOMY AND OCCUPATIONAL TRANSFORMATION

Existing literature has linked some occupational transitions to the pervasive application of ICTs and, in turn, to the information economy. For example, such changes have been found to include the decline of blue-collar and manual workers, the increase of white-collar, knowledge, professional, and non-routine workers, as well as the inconsequentiality of middle managers[15].

The increasing importance of knowledge, professional, and white-collar workers (The decline of blue-collar and manual workers)

The emergence of information/knowledge occupations is arguably the most observable labor market transition in an information economy (Dordick & Wang, 1993; Katz, 1988; Porat, 1977), which has been repeatedly identified and examined in many empirical studies. While reasons for and paths leading to the emergence of information occupations might be dissimilar, such a transition has taken place in both developed and developing countries (Katz, 1988). Machlup (1962) was among the first to observe a fundamental shift from majority employment in manual work (primarily blue-collar and agricultural) to majority employment in knowledge work (primarily white-collar). Bell (1980) followed this line of research and argued that the new economy will progressively give more importance to occupations with a high level of information and knowledge

[15] According to Camarata and Krikorian (1999), white collar is the sum of managerial and professional specialty and technical, sales, and administrative support occupations and blue collar is the sum of precision production, craft, and repair occupations. With regarding to the categorizing of white-collar and blue-collar workers of the directorate for General budget, Accounting, and Statistics, R.O.C., the white collar workers include: business executives and managers, professionals, technicians & associate professionals, clerks, and service workers and sales. As to blue-collar workers, they incorporate labor workers and production machine operators.

content in their activities. He predicted that people would see a growing percentage of white-collar workers in the work force and that the most significant occupational categories would be the professionals, engineers, technicians, and scientists. The shift in employment patterns in the U.S. was also privileged in Martin's (1998) research, where she mapped out a transition from a majority employment in manual work (primarily blue-collar and agricultural) to a majority employment in knowledge work (primarily white-collar). Castells (2004a) also stressed the future trends of increasing jobs in professional fields such as R&D, innovation, design, marketing, and high volume, customized flexible production.

In Taiwan's case, Taiwan's economy has shifted from agriculture to labor-intensive light manufacturing industry, to petrochemical heavy industry, and then to an information-intensive economy. Corresponding to these industrial transitions, the labor structure has also experienced changes from primarily low-skilled occupations, to middle- skilled, and then to higher-skilled, knowledge-intensive occupations (Wei, 2002). Liou (2001) studied the influence of industrial structure transformation on employment and income distribution from 1991-1996 and found the labor structure was actually determined by industrial structure transformation, for example, the shift to an information economy. Not only did the labor in the agriculture and in the traditional manufacturing industries decrease significantly and that in information industries surged, but also with the development of more technique/information intensive industries, the employment of professionals and technicians grew remarkably while that of manual workers and machine operators dropped considerably.

The decline of mid-level managerial occupations or polarization

Another crucial component in the occupational transformation is the decline of mid-level managerial positions, which may arguably lead to the decline of the middle

class and the increase of social polarization (Martin, 1998). Some scholars of the information economy claim that ICTs are facilitating the narrowing and flattening of the managerial structure at the same time. The improved ICTs have reduced the advantages of intrafirm management and performance of professional staff activities and reduced the need for middle managers as conduits for information (Winter & Taylor, 1999). ICTs, as they argue, render information more controllable, on the one hand, and make work processes more visible on the other. In combination, this means that the coordination and control function of the middle management (to progressively analyze and distill information from the shop and pass it up the managerial chain) can largely be replaced by ICTs (Dawson, 1988; Fulk & DeSanctis, 1999; Martin, 1998; Winter & Taylor, 1999; Zuboff, 1988). Such changes in the managerial hierarchies indicate that the ratios among types of workers may change (Martin, 1998).

However, by observing the trends of managers in Taiwan, researchers have made somewhat dissimilar arguments. Tseng (Tseng, 2001a, 2001b) believed that along with the development of Taiwan's information economy, the middle class in Taiwan, unlike in most developed countries, has not declined yet. In sharp contrast, Amsden and Chu (A. H. Amsden & W. W. Chu, 2003) believed that the middle-level managers, engineers, and workers have invariably been subjected to the process of gradual structural unemployment, which will eventually give rise to a shrinking middle class in Taiwan.

In order to figure out the relationship of an information economy and occupational structure transformation in Taiwan, this chapter is going to take a look at the extent of the informatization of different occupations and also the relationship between informatization and income; the occupation structure changes in Taiwan's information economy; and the influential factors of these occupational structure changes.

INFORMATIZATION, OCCUPATION, AND INCOME IN TAIWAN

According to a 2007 survey investigating the digital divide among workers (the Department of Statistics, Council of Labor Affairs, R.O.C., 2008), the occupations who use computers at work from most often to least often ranked in order are: professionals (93.4%), clerks (91.3%), technicians & associate professionals (72.7%), executives & managers (69%), sales & service workers (24.4%), mechanic workers (17.9%), machine operators & assemblers (17.1%), and elementary/labor workers (10.3%). As for Internet use at work, the ranking in order is as follows: professionals (83.3%), clerks (73.8%), executives & managers (60.4%), technicians & associate professionals (56.6%), sales & service workers (15.7%), mechanic workers (10.7%), machine operators & assemblers (6.7%), and elementary/labor workers (2.6%).

The purposes for which computers are utilized at work include the following (multiple choices possible on the survey): document and word processing (81.7%), implementing professional software for job needs (70.2%), collecting needed information (67.4%), contacting customers (54.0%), and product research and design (21.7%).

Next, we will explore the correlation between income and informatization of work, based on a 2005 survey (the Directorate for General Budget, Accounting and Statistics, R.O.C, 2006) (see Table X). If we analyze the computer use rate at work by monthly income, there is a positive relationship; that is to say, the higher the income, the higher the rate of computer use at work. A correlation reveals that income level and computer use are significantly related, with $r = +0.935$, $n = 10{,}177$, $p < .01$, two tails. The only exception was the group with the highest income (monthly income>$3030) whose computer use rate (83.20%) was lower than that of the second highest income group (monthly income between $2424 and $3030), whose computer use rate was the highest (90.10%). The lowest use rate was found in the group with the lowest monthly income (<$480), whose average rate was 49.80%.

Analyzing by income, the results for Internet use were identical to those for general computer use: the higher the income, the greater the use of the Internet at work. A correlation for the data revealed that the level of income and Internet use were significantly related, with $r = +0.965$, $n=9,942$, $p<.01$, two tails. Again, the only exception was that the group with the second highest income had the highest use rate (79.00%), while the group with the highest income had the second highest rate. Thus, according to the statistical data, the extent of informatization is significantly related to workers' income.

Table 2. Use of computers and Internet at work

Use of Computers and Internet at Work—by Industry, Occupation and Average Monthly Income

2005 April Unit: persons ; %

Items	Persons	Using computers at work		Persons	Using Internet at work		
		Ever	Never		Ever	Never	Don't know
Total	10,177	75.6	24.4	9,942	59.5	40.4	
Industry							
Agriculture, forestry & fishing	177	32.9	67.1	171	23.1	76.9	—
Mining & quarrying	19	79.9	20.1	17	52.0	48.0	—
Manufacturing	2,738	73.0	26.6	2,659	53.4	46.6	—
Electricity, gas & water	112	74.3	25.7	97	51.8	48.2	—
Construction	557	61.1	38.9	544	48.8	51.2	—
Trade	1,422	72.5	27.5	1,381	53.6	46.4	—
Accommodation & eating	387	41.4	58.6	386	26.2	73.8	—
Transport & communication	463	67.8	32.2	452	51.0	49.0	—
Finance & insurance	699	95.2	4.8	694	81.2	18.8	—
Real estate	68	78.6	21.4	66	60.1	39.9	—
Professional & technical	485	89.7	10.3	477	78.8	21.2	—
Education	969	91.3	8.7	693	79.6	20.3	0.0
Healthcare	446	83.0	17.0	435	59.2	40.8	—
Culture, sports & entertainment	282	77.2	22.8	291	68.9	31.1	—
Other services	651	59.2	40.8	634	46.8	53.2	—
Public administration	692	95.8	4.2	677	83.2	16.7	0.1
Occupation							
Executives & managers	1,398	83.8	16.2	1,365	71.0	29.0	—
Professionals	2,094	93.6	6.4	2,079	79.1	20.8	0.0
Associate professionals	1,404	80.2	19.8	1,382	64.7	35.3	—
Clerks	2,123	91.4	8.6	2,075	73.9	26.0	0.0
Service workers	1,124	54.8	45.2	1,095	35.4	64.6	—
Agriculture, forestry & fishing	134	25.1	74.9	128	14.0	86.0	—
Mechanic workers	914	43.9	56.1	877	25.2	74.8	—
Machine operators	309	37.6	62.4	297	15.3	84.7	—
Elementary workers	521	37.4	62.6	495	21.1	78.9	—
Others	36	82.3	17.7	36	63.8	36.2	—
Unknown	121	85.2	14.8	110	69.7	30.3	—
Monthly income $ (dollars)							
<480	355	49.8	50.2	348	33.9	66.1	—
480-606	441	52.3	47.4	422	33.5	56.5	—
606-757	1,015	66.6	33.4	990	44.8	55.1	0.0
757-909	1,133	71.0	29.0	1,111	51.8	48.2	—
909-1212	2,194	77.1	22.9	2,151	61.2	38.8	0.0
1212-1818	2,473	81.8	18.2	2,447	68.4	31.6	—
1818-2424	840	87.4	12.6	828	72.9	27.1	—
2424-3030	234	90.1	9.9	233	79.0	21.0	—

Use of Computers and Internet at Work－by Industry, Occupation and Average Monthly Income

2005 April Unit: persons ; %

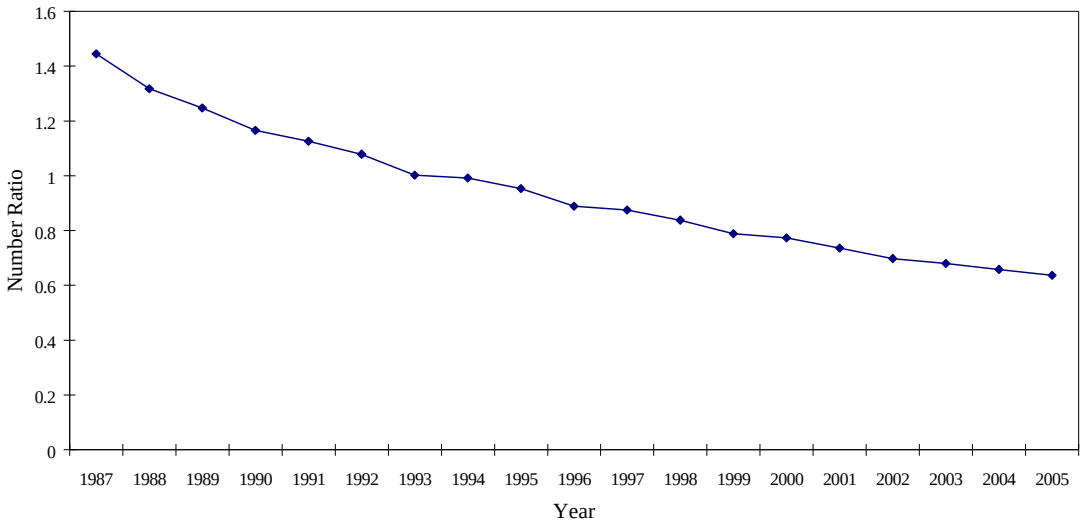
Items	Persons	Using computers at work		Persons	Using Internet at work		
		Ever	Never		Ever	Never	Don't know
>3030	451	83.2	16.8	432	73.3	26.7	－
Unknown	1,043	74.0	26.0	980	55.6	44.4	－

Source: Data from the Directorate for General Budget, Accounting and Statistics, R.O.C

THE OCCUPATION TRANSFORMATION IN TAIWAN'S INFORMATION ECONOMY

Now we want to look into the changing trends of Taiwan's occupational structure after the information economy evolution. We will discuss this from four perspectives: the blue-collar to white-collar employment ratio; the percentage of professional occupations in the total employment; the changing trends in all occupations; and the employment ratio of managers to other occupations.

First of all, Figure 11 shows a decreasing trend in the blue/white-collar employment ratio. The ratio has continued to steadily decline, for example, from 14.4 in 1987 to 0.636 in 2005. The trend displays a continued and steady decline, revealing that, compared to white-collar worker employment, blue-collar employment has continued to decrease in Taiwan.



Source: The author's calculations according to GBAS data

Figure 11. Employment ratio, blue-collar workers to white-collar workers, 1987-2005

Figure 12 demonstrates the growing percentage of professional occupations (professionals, technicians, business executive & managers) in the total employment. For example, in 1981, the percentage of professional occupations counted for only 15.71%, but by 1990, it had become 21.5%, and by 2000, 27.54%. Finally by 2006, it increased to 31.77%. The trend in the employment percentage of professional occupations reveals a relatively steady line of growth as seen in Figure 12.

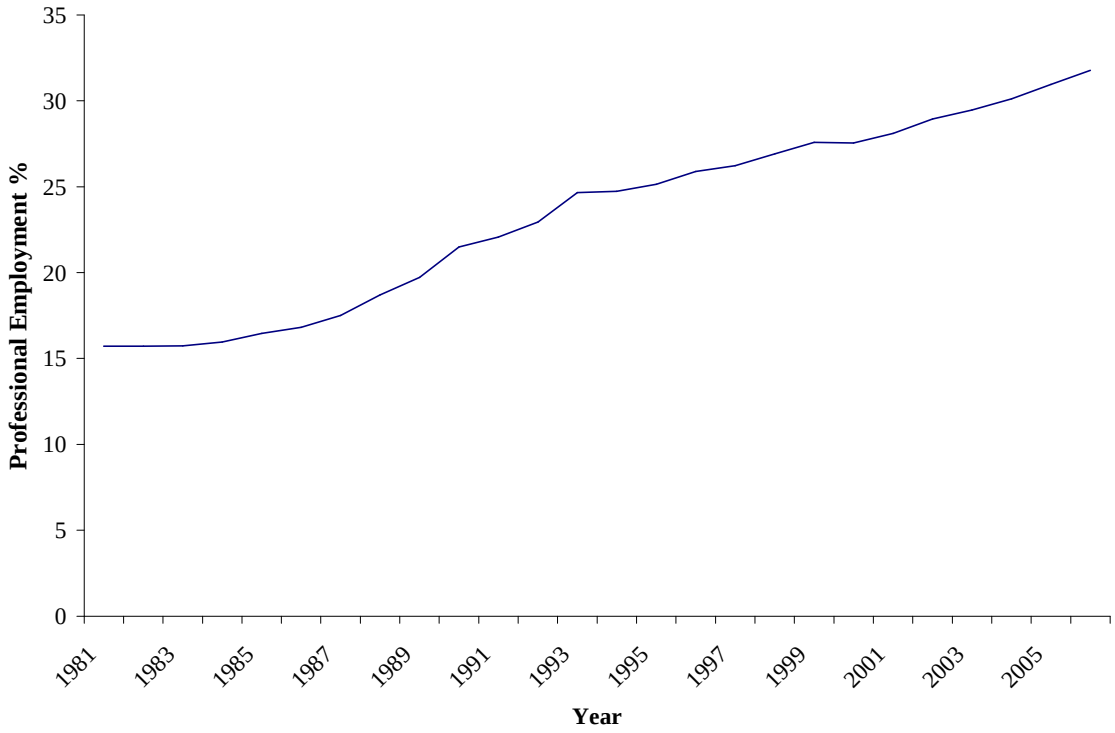
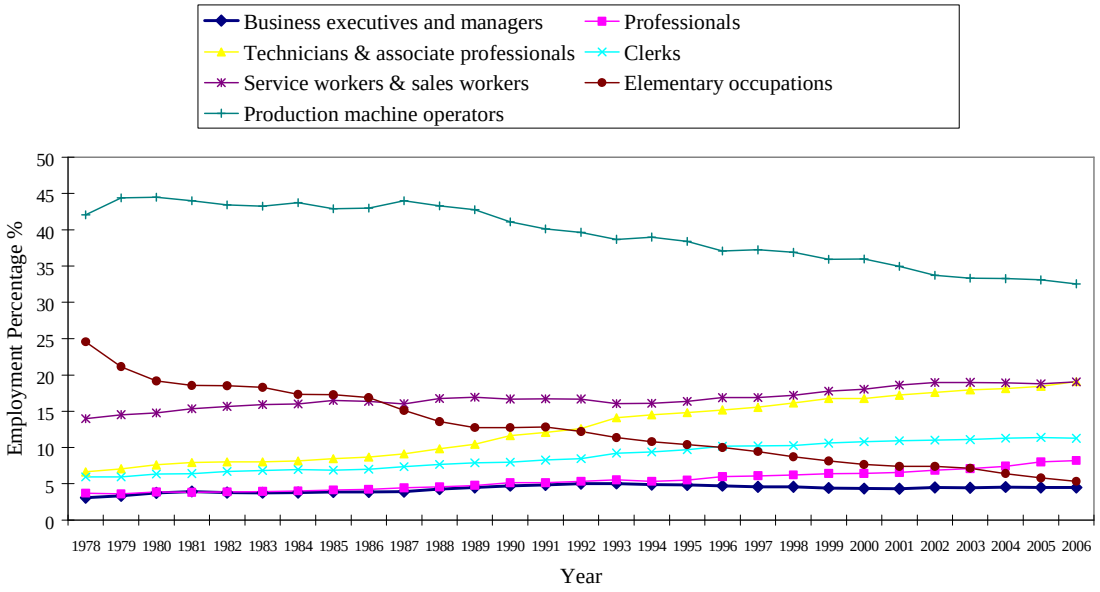


Figure 12. Percentage of professional occupations in total employment, 1981-2006

Figure 13 displays the percentage of each occupational type in the total employment. For example, declining occupations include elementary (labor) workers and machine operators. From 1978 to 2006, the percentage of elementary worker positions in the total employment fell considerably from 24.6% to 5.4%, and the percentage of machine operator positions declined from 42.0% to 32.6%. As predicted in the literature on information economies, the occupations of professionals and technicians increased; professional occupations as a percentage of total occupations increased from 3.7% in 1978 to 8.2% in 2006, and technician and associate professionals increased greatly from 6.6% in 1991to 19.1% in 2006. As for managers and business executives, the percentage of total positions filled by managers and executives in all occupations first increased from 3.1% in 1978 to 5.0% (the highest) in 1993 and then declined to 4.5% in 2006. Overall, the percentage of lower level, less skilled employees (including clerks, service workers, elementary workers, and machine operators) declined from 77.9% to 68.2% and that of

higher level, more skilled employees grew from 22.1% to 31.8%. Nevertheless, the population of lower level workers is still comparatively larger than the number of higher professional and managerial positions.

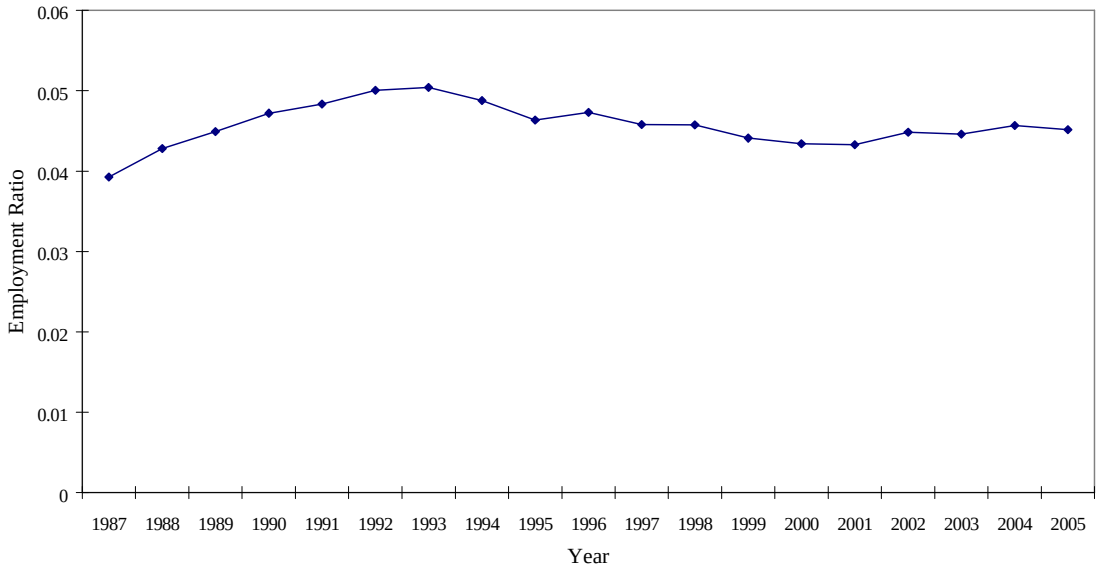


Source: The author's calculations based on GBAS data

Figure 13. Employment percentages of all occupations, 1978-2006

Another crucial aspect of occupational transformation is the decline of managerial occupations. Information economy scholars claim that informatization and ICTs are facilitating the narrowing and flattening of managerial structures; ICTs render information more controllable, on the one hand, and work processes more visible, on the other. In combination, this means that the function of middle management (to progressively analyze and distill information from the shop and pass it up the managerial chain) is largely taken over by ICTs (Dawson, 1988; Fulk & DeSanctis, 1999; Zuboff, 1988). Moreover, not only are managerial hierarchies flattening, but they are narrowing at the same time, which means the ratios among types of workers may change (Martin, 1998).

Figure 14 reveals the change in the importance of managerial occupations. We can first see a climbing trend in the ratio of management to other occupations from 1987 to 1992. Later, during the time of increasing informatization, the ratio did gradually decline from the peak in 1992 at 0.050 to 0.045 in 2005; however, the movement was slight rather than substantial.



Source: Author's calculations and GBAS data

Figure 14. Employment ratio of managers to other occupations

DETERMINANTS OF OCCUPATIONAL STRUCTURAL CHANGES IN TAIWAN'S INFORMATION ECONOMY: ESTIMATION AND RESULTS

The analysis of changes in the occupational structure suggests that as the economy of Taiwan has transitioned to an information economy, there have been significant changes in the occupational structure of the economy. The question that is raised is whether the changes in the occupational structure are related to the increasing informatization of the economy and, if so, to which components of the informatization process. In addition, can we isolate the impact of informatization from the broader

growth of the economy as a whole? The section attempts to investigate these questions statistically.

A review of the literature shows that there are three important components of the occupational structure of Taiwan's economy that are relevant to the investigation of the impact of informatization: first, the ratio of blue-collar to white-collar employment; second, the proportion of professional occupations in total employment; and third, the ratio of managers to other occupations in the labor force.

With respect to informatization, relevant studies apply three measures to the assessment of changes in the occupational structure (please refer to Chapter 2). The first measure identifies the extent of the informatization of the economy, measured by the percentage contribution of information intensive industries to the total GDP. Secondly, the informatization of production is measured by the extent of automation in the economy (the automation equipment density in businesses)[16] and the informatization of production, as measured by percentage of R & D in the total GDP. Finally, information infrastructure and IT usage is quantified by calculating personal computers per 100 inhabitants, Internet users per 100 inhabitants, main telephone lines per 100 inhabitants, and mobile cellular phone subscribers per 100 inhabitants.

Because changes to occupational structure could be an outcome of general economic trends in the economy as a whole, in order to isolate the impact of informatization from co-existing general economic trends, Taiwan's gross domestic product is used as a control variable in the current analysis. Moreover, all the variables are calculated by their first difference ($a_t - a_{t-1}$, $b_t - b_{t-1}$.....) to avoid the possibility of suspicious correlation.

[16] Relevant indicators such as computer ownership and Internet use rates in Taiwan businesses are lacking.

Table 3. Correlations for imformatization and occupation changes controlling for GDP, 1990-2007

	Blue/white-collar employment ratio	Professional employment percentage	Manager employment ratio
Informatization of the economy	.971**	.997**	.003
Percentage of R & D in the total GDP	.982**	.995**	-.022
Automation equipment density	.971**	.970**	-.089
Personal computers per 100 inhabitants	.977**	.963**	-.0.091
Internet users per 100 inhabitants	.979**	.984**	-.111
Main telephone lines per 100 inhabitants	.972**	.995**	-.013
Mobile cellular telephone subscribers per 100 inhabitants	.907**	.911**	-.213
N	15	13	16

Note 1:Control variable: GDP
Note 2: ** denotes that the value is significant at the 0.01 level (2-tailed).

From the statistical data shown in Table 3, we see that all the informatization indicators reveal strong and statistically significant correlations with blue-collar to white-collar employment ratio, thereby supporting most of the information society studies that as the extent of informatization increases, the number of blue-collar workers might decrease, as compared to white-collar workers. Similarly, all the informatization indicators demonstrate strong and statistically significant correlations with professional

employment percentages in the total employment, conforming to the argument that a rise in information economy would correlate to a growing need for professional occupations.

As for managerial occupations, none of the informatization indicators reach statistically significant levels and they demonstrate a weak correlation with changes in managerial occupations. This result demonstrates that Taiwan has experienced a different situation from that observed in other developed countries, where the development of IT tends to lessen the importance of middle level managers.

In summary, when the economic growth factor (GDP) is controlled, we still find that informatization is highly correlated to the declining trend of blue-collar occupation, as compared to white-collar workers, and to an increase in professional occupations. As for informatization indicators and managerial occupations, none of the indicators reach statistically significant levels and thus cannot support the supposition that informatization contributes to the waning importance of managerial occupations in Taiwan.

CONCLUSION

The empirical analysis of changes in Taiwan's occupational structure in its transition to an information economy reveals several important findings. First of all, both the computer use rate and the Internet use rate are positively related to income. Second, compared to white-collar workers, the employment of blue-collar worker has continually fallen since the 1980s along with the development of information economy in Taiwan. Third, the percentage of professional occupations (professionals, technicians, and business executive & managers) in the total employment has continually grown since 1981. Fourth, related to the changing trends in all categories of occupations, elementary (labor) workers and machine operators obviously declined. In contrast, the percentage of professionals and technicians, especially that of technicians, kept growing. The percentage of service workers & sales and clerks also grew but to a smaller extent.

Finally the percentage of managers increased at first, but then declined a slight extent after 1993.

The correlation analysis shows that the advent of informatization did highly correlate to the decline of blue-collar jobs and the growth of professional occupations, but this was not consistent with the case of most developed countries, where there is a declining trend in the number of middle level managers as the information economy develops.

Based on the findings in this chapter, we can conclude that with the development of an information economy, Taiwan has undergone changes similar to those of developed countries in its occupation structure. These similarities include a rise in number of professional and white-collar occupations such as professionals, technicians, service workers, and sales, as well as a decline in the number of blue-collar and manual workers, such as labor workers and machine operators. However, the occupation that has grown most quickly in Taiwan is that of technicians, which, to be accurate, should be recognized as a semi-professional/skill occupation rather than a high-tech or high knowledge occupation. This phenomenon reveals that, as an NIC, Taiwan has an information economy that is mainly the semi- periphery of developed countries, by outsourcing for international name brands that control the highest level of R & D and also the most crucial production knowledge.

Moreover, unlike what the literature review points out, Taiwan has not exhibited an obvious decline in the importance of middle managers. One possible reason for this may be, as Jonscher's argument goes, that "when industrial technology develops, the process of production leading to the final output of goods and services in the economy would become more complex and the organizational or informational task of coordinating the diverse steps in the production chain grows " (Jonscher, 1983, p.15). Jonscher argued that, although technical progress increases individual worker's production efficiency, the consequences for the economy as a whole are an increase in

complexity. The number of transactions among business units and of internal transfers on intermediate goods and services within business units grows, which brings about an increase in the informational tasks of managing and coordinating the economy.

Overall speaking, the changing trends of occupation structure under the transformation to an information economy has made Taiwan's labor market more unbalanced, benefiting workers more skilled with information, more professional, and having a higher level of education, which inevitably deteriorates the labor market inequality and bias.

Chapter 5: The Information Economy and Employment

INFORMATION ECONOMY AND EMPLOYMENT

When considering the dynamic relationship between information economies and employment, scholars have diverse observations, viewpoints, and explanations. The relevant arguments can be generally categorized into four different groups: 1) informatization will enhance employment; 2) informatization will reduce employment; 3) long-term balance will be reached between employment and unemployment; and 4) the situation will be different depending on the industry and country.

Enhancement of employment and international competitiveness

Some scholars argue that the adoption of new production technologies such as ICTs improves productivity and stimulates market demand, which in turn generates higher output and provides more employment opportunities (Campbell, 2001; Freeman et al, 1995). A related explanation transforms this idea by incorporating a global competitive perspective i.e., the rapid acceptance of new technologies will increase productivity in traditional industries and thereby provide an international competitive edge, which will translate into market growth and, in turn, more employment (Jennie, 1983). Furthermore, the emergence of ICT industries such as hardware and software industries, Internet service providers (ISPs), and the online-game industry, has also created a great number of jobs (OECD, 2002). Additionally, Soete (2001) indicated that the increased number of jobs created by the development of ICTs in the service sector is more than able to absorb the jobs lost in the manufacturing and agriculture sectors, resulting in an overall increase in employment within the society.

Reduction of employment

Although in agreement with the positive technological effects on productivity, some scholars take exception to the idea of employment enhancement due to ICT

adoption. They report that there is a correspondence between technological use (improved productivity) and an increase in unemployment (Aghion & Howitt, 1998; Cyert & Mowery, 1989; Mills, 1938). For example, Webster and Robins (1986) concluded that ICTs will only create further unemployment because: (a) even in areas of economic growth, employment does not necessarily need to expand with increased productivity; (b) the motivation of the extensive application of the ICTs is to save on expenditures rather than to increase employment; (c) in all advanced capitalist societies, new technologies are being introduced to counter the threat of higher productivities from other nations, which very likely will lead to cheaper production, less employment, and little overall economic change; (d) employment within the service sector is barely increasing at the moment and is likely to decline in significant areas in the future because of the application of ICTs; and (e) demographic trends further exacerbate the unemployment problem brought on by ICTs.

Long-term balance of employment and unemployment

Some scholars take a quite different approach toward the relationship between an information economy and employment. Rather than focusing on the specificity of new technologies' impact on employment in the short-term, they maintain that an employment equilibrium will be achieved in the long term (Sleigh et al., 1979). It is the market price mechanism, they argue, that will ensure that demand and supply of labor will adjust to one another. As a consequence, long-term unemployment caused by technologies is impossible. Moreover, the impact on employment from ICTs will be like swings and roundabouts, with some job loss over here and some gains over there; yet some sort of equilibrium will be reached ultimately (Sleigh et al., 1979).

Differences by region, industry, or occupation

Some scholars such as Castells (1996b), argue that there is no systematic structural relationship between the diffusion of ICTs and the evolution of employment

levels in the economy as a whole. He indicated that the impact of ICTs on employment varies by country, region, and industry because of the mediation of different macro-economic factors such as economic systems or the nature of industries (labor-intensive or technique-intensive). Using another approach, Galbraith (2000a) conducted his analysis by dividing the economy into different sectors. He first pointed out that the technology/worker relationship in the capital sector is a relatively more complementary and interdependent one. In other words, it is more difficult to replace workers with machines in the capital sector. However, in the consumer goods sector, technology and machines can take the place of workers because their relationship is better characterized as interchangeable. And finally, the hardest hit by technologies will be sustained by the service sector, where workers are mostly lower-skilled and are the easiest to replace with technology (Galbraith, 2000).

Relevant Research in Taiwan

When considering the dynamic relationships between the information economy and employment, some researchers (*Economic yearbook of the Republic of China*, 2006; M. C. Tsai, 2005; Wei, 2002) subscribe to the idea that Taiwan's information economy should be held responsible for Taiwan's deteriorating employment. As Wei (2002) observed, the information economy has made Taiwan's industrial structure experience considerable changes. Some industries, especially the traditional industries, confronted recession and laid off a huge amount of workers; however, these workers did not transfer successfully to the new blooming industries, mainly the information-intensive industries, which resulted in a serious unemployment problem in Taiwan. Information-intensive industries, compared with traditional industries, have created fewer job opportunities. In fact, they are believed to have hired significantly fewer workers because their productivity is almost already highly automated (Tsai, 2005). Another research study also supported this viewpoint (Hsin, 2004). According to Hsin, among the four primary

manufacturing sectors (mechanical, metal mechanical, chemical, commodity, as well as information & electronics), information & electronics had a negative labor cost growth rate, and the falling rate was the greatest. Drawing from Hsin's research, the main reason for this was the large extent to which information & electronics adopted labor-saving production automation. Yu (2004) shared similar observations, pointing out that the high speed of the information technology such as the Internet creates higher productivity, which can ultimately lead to significant reductions in labor costs. Failures to create more job opportunities will necessarily lead to a profusion of unemployment.

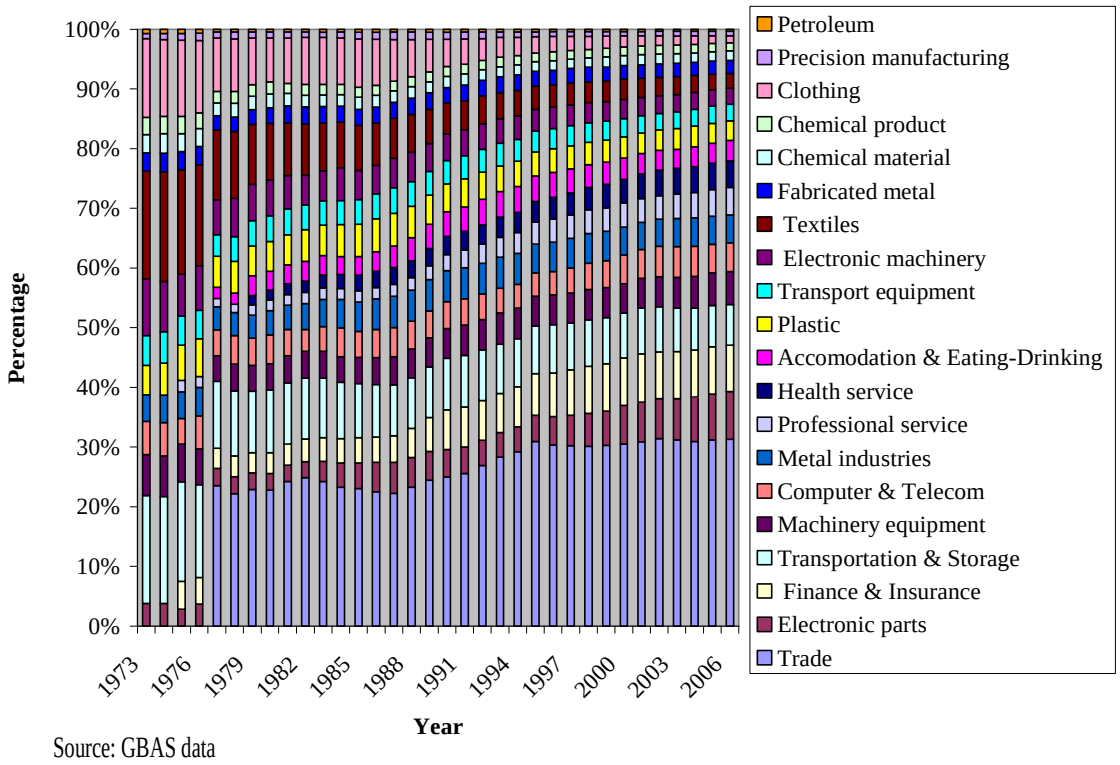
In order to look into this issue, this chapter will discuss recent employment trends in representative industries, such as labor intensive industries, and information intensive industries, and will track the determinants of unemployment and the enlarging informal sector[17] in Taiwan.

THE EMPLOYMENT TRENDS OF INFORMATION INTENSIVE INDUSTRIES IN TAIWAN

Now we want to first take a look at the employment trends of Taiwan's industries in the last three decades. We see in Figure 15, just as expected, that employment in traditional and labor-intensive industries did continue to decline along with the economic transformation from labor-intensive to information-intensive/high-tech industry. Some representative examples of industries that have declining unemployment trends are clothing, textiles, electronic machinery, plastic, and transportation & storage. For instance, the percentage of the clothing employment in total employment dropped from 13% in 1973 to 9% in 1980 and to less than 1% in 2006. As for the textile industry, the percentage of the total employment represented by this industry dropped from 18% in

[17] Informal sector, according to the DGAS, R.O.C., refers to the percentage of people who are older than 15 years old but do not work and or look for a job for all kind of reasons in the entire labor force. The entire labor force refers to people who are over 15 years old and have capacity to work.

1973, to 10%, in 1980, and then to a mere 2% in 2006. In contrast, the service and information-intensive industries began to account for a greater and greater share of the total employment. Some representative examples include trade, electronic parts, finance & insurance, professional services, and health services. For instance, the percentage of the total employment represented by the electronic parts industry was 3% in 1973, stayed relatively constant through 1980, and grew to 7% in 2006. The trade employment grew from 21% in 1980 to about 25% in 2006. Financial employment increased unevenly from 3.5% in 1975 (the earliest year of data available) dropped slightly in 1980 to around 2%, and then rose to 8.5% by 2006. Employment in professional fields was around 1% of the total employment in 1975, stayed around the same in 1980, and increased slightly to about 3% in 2006. The big employment loss in labor-intensive industries has not seemed to be absorbed to a great enough extent by information-intensive industries' we will discuss this further later in this chapter. As to the industries that have maintained a similar level of employment, they include computer & telecommunication, machinery equipment, and metal industries.



Source: GBAS data

Figure 15. Employment trends of different industries, 1973-2006

If we compare the employment percentage to the GDP percentage, Figure 16 shows us the percentage of each industry in the total GDP. For example, the GDP percentage of electronic parts increased 10.5% from 1981 to 2006; however, its employment percentage grew only 4% during the same time period. As for the computer and telecommunication products industry, its GDP percentage increased about 2.5%, but its employment percentage did not grow at all.

In contrast, the GDP percentage of the trade industry did not grow; however, it contributed to a 4% increase in the total employment. Similarly, finance did not increase very much in its percentage of the total GDP, but it contributed to a 5% increase in the total employment. The GDP percentage of professional and technician services grew only 0.5%, but its employment percentage increased 2%. The percentage of the GDP represented by health services grew only 1.5%, but employment in this sector grew by 3%.

As to the traditional labor-intensive industries, its percentage of total GDP dropped 8%, and its employment percentage dropped 7.5%. Textiles dropped 7.5% in GDP and around the same percentage in the total employment.

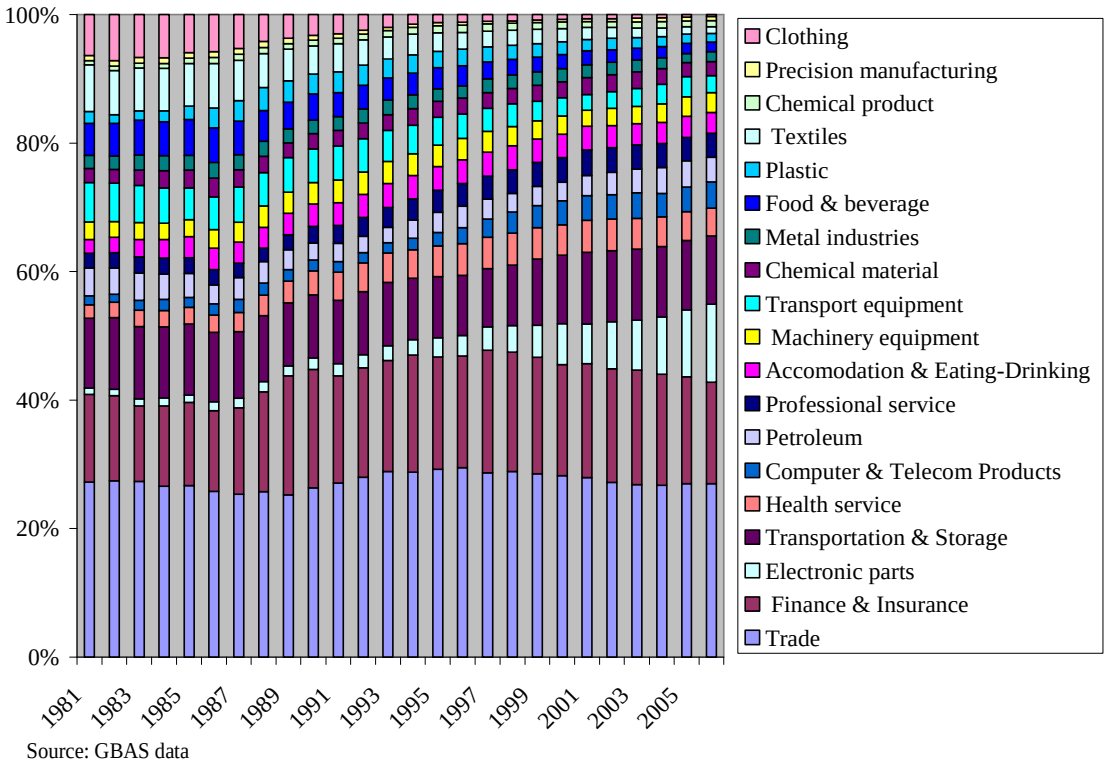


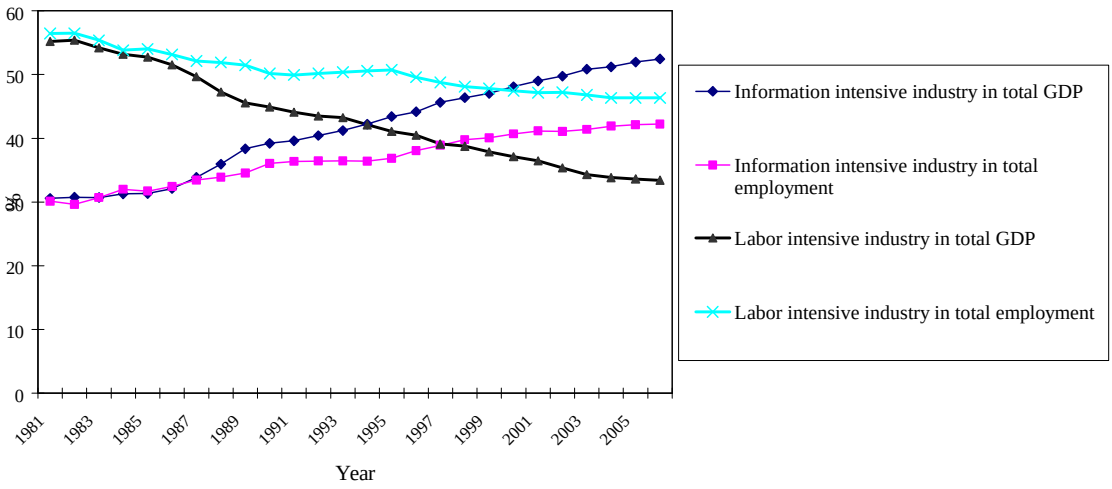
Figure 16. GDP trends of different industries, 1981-2005

Overall speaking, we can observe that, compared to its increase as a percentage of the total GDP, information-intensive manufacturing actually did not contribute a corresponding increase to the total employment. The centers for job creation and also the new shelters for workers who lost jobs in labor-intensive industries have been the common service sectors such as trade, and also the information-intensive service industries such as finance, professional services, and health services.

Next, we want to combine all the information-intensive industries and all the labor-intensive industries together to understand the changes in employment trends. Figure 17 shows us the employment gap (or loss) that the information-intensive industries

caused. Around 1981, in the initial stage of Taiwan's information economy, the proportions of information-intensive industries in the total GDP and in the total employment were fairly close: 30.6 % and 30.1% respectively. But in 1999, the contribution of information-intensive industries to the total GDP reached 47.0% but only reached 40.1% with respect to the total employment. In 2006, the gap grew to 52.5% and 42.2% respectively. The employment gap continues to grow, most likely due to production automation. In any case, the phenomenon of the widening employment gap shows us that the contribution of information-intensive industries to the total employment does not equal its contribution to the total GDP.

Another way to think about this problem is to compare the employment ratios of traditional labor-intensive manufacturing. This traditional industry offered Taiwan almost "full employment" during the 1960s and 1970s unlike the current situation with the information intensive industries. After Taiwan's industrial transition from labor-intensive manufacturing to an information-intensive economy, the employment ratio (of total employment) of the information-intensive sector (including both manufacturing and service sectors) rose from 33.6% in 1977 to only 42.2% in 2006, increasing only 8.6%. In contrast, for labor-intensive manufacturing alone (not including labor intensive service or other industries), the decline was as much as 32.7%, dropping from 41.3% to 8.6%. The increase in the employment ratio of the information-intensive sector (8.6%) lags far behind the employment decline in labor-intensive manufacturing (32.7%). Moreover, because the available statistical data were only from 1977, not from the peak period of labor-intensive manufacturing (1960-1970), the contribution of labor-intensive manufacturing to the total employment is still underestimated.



Source: Calculated based on W. C. Wang (2008)

Figure 17. Employment gap in the information economy, 1981-2005

TAIWAN'S UNEMPLOYMENT

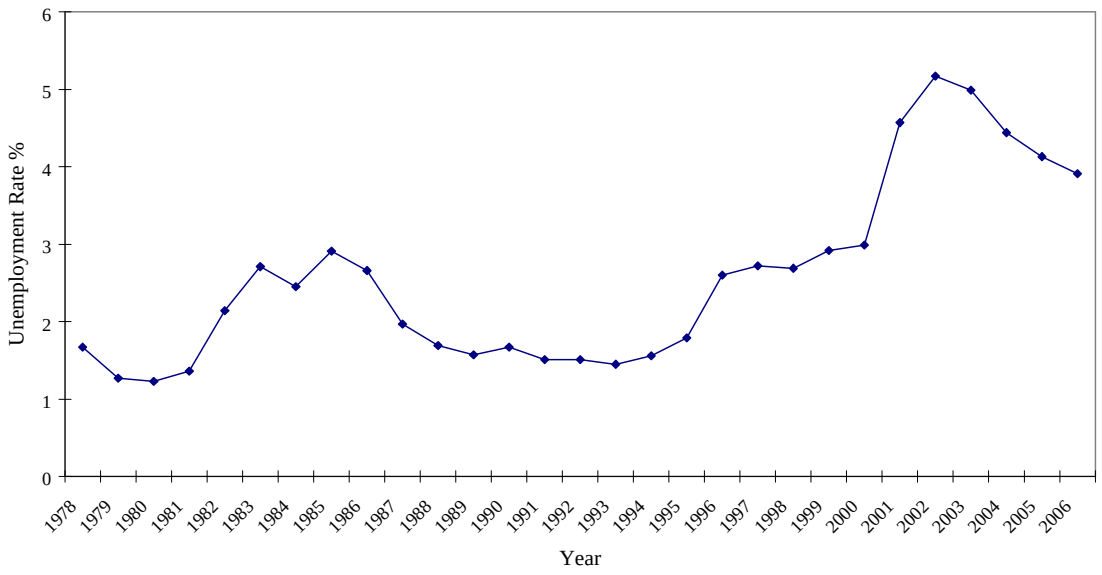
After understanding the employment loss that the economic transformation (to an information economy) caused, we now want to pay attention to the actual situation of Taiwan's employment trends, especially during and after the economic transition to an information economy.

Figure 18 shows unemployment [18] trends in Taiwan from 1978 to 2006. If we consider Taiwan's industrial history, we see that before the 1980s (especially in the 1960s and 1970s), Taiwan had a very low unemployment rate because of strong labor-intensive industries such as clothing and textiles. In the 1980s, however, Taiwan underwent a

[18] Unemployment rate, according to the Directorate-General of Budget, Accounting, and Statistics, R.O.C., refers to the percentage of the unemployed in the entire labor force. The entire labor force refers to people who are over 15 years old and have capacity to work. The unemployed refer to people who: (1) have no work; (2) can work right away; and (3) are now looking for a job. Moreover, people who have found jobs but are still at the stage of waiting to start working are also incorporated in the unemployed.

dramatic industrial transformation, shifting from labor-intensive manufacturing to an information-intensive economy, which worsened the unemployment problem. Because information-intensive industries, especially the information manufacturing sector, are mainly technique/knowledge centered, not labor centered, and their production has become highly automated, they hire fewer workers, particularly fewer lower-skilled workers than traditional labor-intensive industries,

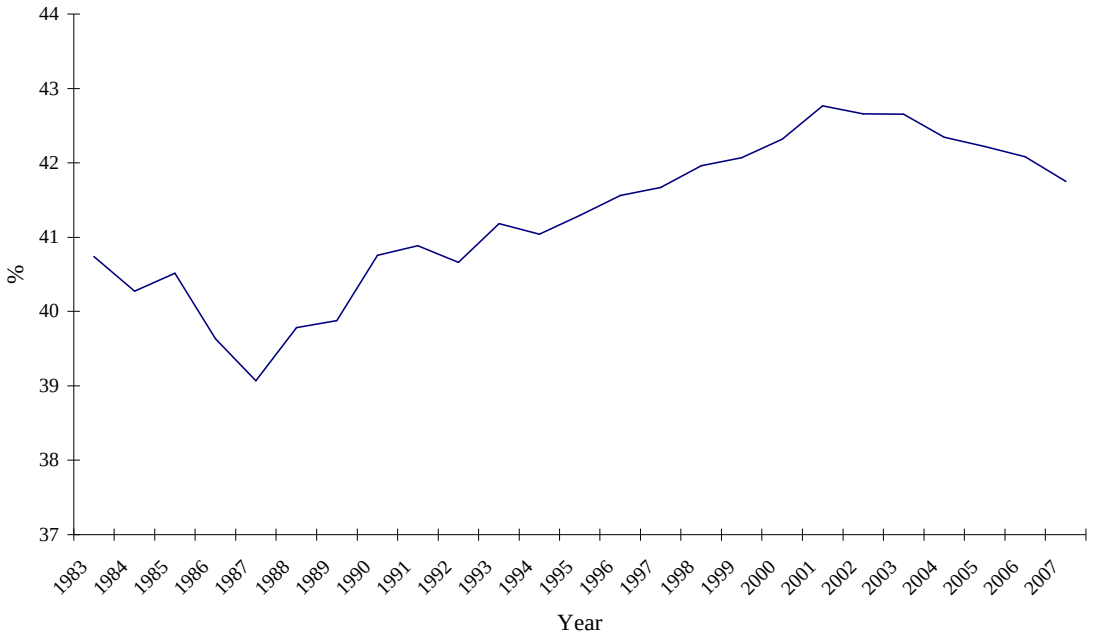
Moreover, in the first half of the 1990s, Taiwan opened its doors to immigrant workers from Southeast Asia and also began to allow outward investment in China. This was done in order to help keep industries and investment in Taiwan and also to facilitate the industrial upgrade to information-intensive and hi-tech industries. However, these two policies resulted in both the replacement of lower-skilled domestic workers and the so-called second wave of exportation of Taiwan's industries (this time also including the labor-intensive departments of the Taiwanese information industries). These two factors are also believed to have worsened Taiwan's unemployment problem. Likewise, some information-intensive service industries such as finance and telecommunications experienced labor saturation and were unable to absorb the redundant labor force from manufacturing layoffs that occurred because of plant relocations to China, resulting in even greater unemployment. As a result, during the worldwide recession from 2000 to 2003, Taiwan's unemployment rate reached a historical high of 5.2% in 2001. After 2003, although the economy gradually returned to normal and the unemployment rate gradually declined, the unemployment rate was still as high as 3.9% in 2006, much higher than in the 1980s, when the high was only around 1.2%. Consequently, we can observe that in Taiwan's case, the information economy has not significantly contributed to employment; on the contrary, it may have worsened the unemployment problem.



Source: GBAS data

Figure 18. Unemployment rate, Taiwan, 1978-2006

Similarly, if we consider the information economy and acknowledge that it has less potential to offer mass employment from another aspect i.e., the informal sector (see Figure 19), we find that in the beginning stages of the information economy, the informal sector decreased due to the labor demand of new industries. But beginning in 1987, the scope of the informal sector gradually increased until it reached a historical high point around 2001 and 2002 when the worldwide IT industry was in a recession. Unemployment hit a historical high as well, and then after 2003, the scope of the informal sector slightly shrank, but, similar to the unemployment rate, it still maintained a much higher level then in the age of a labor-intensive economy.



Source: GBAS data

Figure 19. The scope of informal sector, Taiwan. 1983-2007

Overall we can see that actually Taiwan's information economy, especially information-intensive manufacturing, has not contributed as much to employment as labor-intensive manufacturing did in the 1960s and 1970s. The employment gap this has caused continues to grow, and it is evident that the unemployment problem worsened after 1980, coinciding with the establishment of the information economy. For more evidence, this paper will also demonstrate the statistical relationship between the information economy and unemployment in the next section.

DETERMINANTS OF UNEMPLOYMENT IN TAIWAN, 1990-2007: ESTIMATION AND RESULTS

In order to further understand the role of informatization in the changing employment patterns in Taiwan, we need to evaluate the relationship between

information technology and unemployment and attempt to isolate the impact of informatization from the general economic trends of the economy.

Here I use two variables to indicate the employment patterns in Taiwan: the unemployment rate and the size of the informal sector. With respect to informatization, as in Chapter 4, I will use the extent of the informatization of the economy, measured by the percentage contribution of information intensive industries to the total GDP; the informatization of production, measured by the extent of automation in the economy (the automation equipment density in businesses); [19] the informatization of production, measured by percentage of R & D in the total GDP; and information infrastructure and IT usage, quantified by calculating personal computers per 100 inhabitants, Internet users per 100 inhabitants, main telephone lines per 100 inhabitants, and mobile cellular phone subscribers per 100 inhabitants. Likewise, changes in employment patterns could result from general economic trends in the economy as a whole; thus, we also need to control for Taiwan's gross domestic product in the current analysis.

[19] Relevant indicators such as computer ownership and Internet use rates in Taiwan businesses are lacking.

Table 4. Correlations for informatization and unemployment controlling for GDP, 1990-2007

	Unemployment rate	Informal sector rate
Informatization of the economy	.858**	.998**
Percentage of R & D in the total GDP	.894**	.997**
Automation equipment density	.936**	.973**
Personal computers per 100 inhabitants	.863**	.969**
Internet users per 100 inhabitants	.922**	.983**
Main telephone lines per 100 inhabitants	.858**	.996**
Mobile cellular telephone subscribers per 100 inhabitants	.900**	.921**
N	15	13

Note 1:Control variable: GDP
Note 2: ** denotes that the value is significant at the 0.01 level (2-tailed).

The data from Table 4 show us that all the informatization indicators are both statistically significant and strongly correlated to the two unemployment variables: unemployment rate and the size of the informal sector. Moreover, in all cases, the direction of correlation between informatization indicators and the two unemployment patterns is strongly positive—the higher the degree of informatization, the greater the tendency toward unemployment. Thus, we can say that Taiwan's increasing unemployment in the last two decades is highly correlated to the development of

informatization and information economy. This result supports those who argue that informatization and information economy would result in increasing unemployment.

CONCLUSION

In summary, Taiwan's unemployment rate had grown steadily since 1980, hitting its highest point at 2002-2003 during an economic recession in global IT industries, and then dropped a little but still remained at a much higher level than before. Similarly, the scope of Taiwan's informal sector started to grow around 1987-1988, hitting its highest point in 2003, then dropping a little and remaining at a high level just as the unemployment rate did.

This chapter also tracked the sources of how this increased unemployment and enlarged informal sector were caused. It first looked into the individual industries and finding out that, compared to the increase in the total GDP, information-intensive manufacturing did not actually contribute as much to employment as it did to the total GDP. The industries making up for the employment loss in the transition from labor-intensive to information -intensive industries were mainly the common service industries such as trade, and also information-intensive services such as finance, professional services, and health services. In addition, many workers who failed to transfer to information manufacturing or to service sectors became unemployed and fell into the informal sector.

I also combined all the information-intensive industries and all the labor-intensive industries together and then compared these two big sectors by their GDP and employment contribution. The results show that the increase in the employment ratio of the information-intensive sector lags far behind the employment decline in labor intensive-manufacturing. Moreover, in the early 1980s, the proportions of information-intensive industries in the total GDP and in the total employment were fairly similar.

However, in 1999, the contribution of information-intensive industries to the total GDP reached 47.0% while, with respect to the total employment, it only reached 40.1%. In 2006, the gap reached 52.5% and 42.2% respectively. The employment gap continues to grow, which predicts a continuing problem of unemployment.

This dissertation also offers a statistical examination of the relationship between informatization and unemployment patterns in Taiwan. The results indicate that the increasing unemployment trend that developed after 1990 is strongly and positively correlated to the development of informatization and information economy.

Overall, this chapter reveals that the unemployment problem that arose after Taiwan's transformation to an information economy is closely related to the inability of information-intensive industries (especially information manufacturing) to absorb the labor released from labor-intensive industries. The most likely reason for this is that the high degree of automation of production in information-intensive manufacturing results in a reduced need for labor in the relevant businesses. Unlike other information societies, especially in developed countries such as the U.S. or the U.K., which have already outsourced most of their information-intensive manufacturing to other countries, Taiwan still greatly relies on IT manufacturing for economic growth and employment. The less developed information-intensive services and R & D activities in Taiwan and the inability of information-intensive manufacturing to create more jobs are two main reasons for Taiwan's present unemployment situation.

Chapter 6: Taiwan's Information Economy and Wage Inequality

Information economies are often linked to increasing economic inequality because of a tendency toward growing wage disparity. This chapter will explore whether Taiwan experienced a similar phenomenon, will analyze the sources of this trend, and will also identify the reasons for this rise in wage disparity during the transition to an information economy.

INFORMATION ECONOMY AND INEQUALITY

When considering which exact factors contribute to an increasing trend of wage disparity in an information economy, different approaches of thinking often imply different policy applications and also different political positions. These different reasons can be categorized into three main different approaches: information/informationalism, technology (skill-biased technological changes), and political economic reasons.

Information, knowledge, education, and informationalism

1. Information, knowledge, and informationalism

Castells (1996) is arguably one of the most prominent scholars to point out the transformation in the labor forces taking place throughout the world during the rise of the information age, a process he calls "informationalism." This term indicates a specific form of social organization in which information generation, processing, and transmission become fundamental sources of productivity and power (Castells, 1996a). According to him, the new dominant social and economic systems are characterized by informationalism, which creates a sharp divide between valuable and non-valuable people and locales, including and excluding segments of economies and societies in and out of the networks of information, wealth, and power. The exclusion of certain people and territories from the perspective of informational capitalism forces them into a position of structural irrelevance. This social exclusion leads to what Castells calls "the

black holes of informational capitalism" (Castells, 1998, pp. 70-165). He further explains this increased inequality through analyses of the shifting occupation structure. Three-fourths of the new occupations since the 1980s have been low-skilled work for wages in the U.S. This occupation transformation speeds up the decline of middle-level jobs and the middle class, which results in the polarization of work and wages, along with a clear increase in economic inequality (Castells, 1988).

Prior to Castells' research, Bell (1973) proposed that knowledge and information have become directly productive forces, and information is the crucial raw material from which most social processes and social organizations are made. However, unlike Castells, Bell did not think that information and IT would deepen inequalities in society; on the contrary, he was convinced that when knowledge production and knowledge workers become the primary share of economic activities and structure, society will become a more equal one and people will enjoy better welfare provided by IT's pervasiveness.

The above-mentioned argument highlights the importance of information and knowledge on dividing the labor force market. Nonetheless, there is little proof from empirical studies regarding the existence of a relationship between these two. This is partly due to the difficulty of measuring the actual quantity of information/knowledge input into the production processes. In addition, the observed tendency of the declining wage of less-skilled workers can also be easily ascribed to other technological, social, economic, or policy factors, which we will revisit in later sections.

2. Information, IT, and education

Another viewpoint differing from the previous one is focused on education and learning. This perspective claims that, for the crucial role of knowledge and technique in the information society, education and continuous learning would become the main factors determining a worker's rewards in the labor market. In other words, in this kind of view, there should be an observed increase in the relative wages of workers with better

education, which is called a “rise in the rate of return to skill” or an “increase in the skill premium” (cited fromGalbraith, 2000d, p. 24; Steelman & Weinberg, 2005, pp. 12-14). Expanding the idea of education to a boarder scope, Juhn, Murphy, and Pierce (Juhn, Murphy, & Pierce, 1993) categorized three different patterns of rising inequality regarding learning and education. (1) One is related to experience— years in the labor force. (2) The second is associated with the years of education. (3) The third is unobserved skill—a residual to any measurable characteristic. Information technology is believed to play a crucial portion here because it turns information into useful knowledge for production efficiently, and thus, the acquirement of information technology technique would be also emphasized in an information economy (Tseng, 2001b).

Different from the above argument, for Steelman and Weinberg, education would narrow the gap in economic inequality for the labor force will respond to the premium on education by increasing the investment in education. From this viewpoint, investment in education could be an effective tool in reducing wage inequality and could yield additional benefits to the economy such as increasing workers’ productivity (Steelman & Weinberg, 2005).

However, scholars such as Galbraith (2000d) do not agree that education is the determining reason causing economic inequality or equality nowadays. For Galbraith, education systems do not determine economic structures; in contrast, education is the follower of economy—when economy becomes more dispersed, so does education. The structure of earnings for workers would not change only because of more workers’ acquisition of higher education. Thus, it is possible that when more workers get more education, the demand for even higher education will enhance as well.

Information technology and skill-biased technological changes

When considering the trends of an increasing wage for the more skilled labor in many developed countries, some scholars (Autor, Levy, & Murnane, 2002; Krueger, 1993; Steelman & Weinberg, 2005) tend to adopt a position of more direct technological determinism, arguing that IT, especially microcomputers, actually leads to the growth of wages for more professional workers; they name this dynamic process "skill-biased technological change." Such a change refers to the phenomenon that technological change improves the productivity of skilled workers more than that of less skilled workers, thus shifting the demand for labor toward more skilled workers and boosting their wages accordingly (Autor et al., 2002; Krueger, 1993; Steelman & Weinberg, 2005). This school of thought claims that technology and automation are most easily applied as replacement for low-skill jobs; the operation of new technologies typically requires more skills, and cheapening labor is not the primary criterion in decisions to implement new technologies (Attewell, 1987; Welch, 1970).

As explained by Autor, Levy, and Murnane (Autor et al., 2002), computer technology effectively substitutes for workers performing routine tasks that can be readily done with programmed rules, while complementing those workers executing non-routine tasks that involve flexibility, creativity, generalized problem-solving capabilities, and complex communications. These two mechanisms—substitution and complementarity—increase the relative demand for workers who hold a comparative advantage in non-routine tasks and further the wage disparities between them and other workers.

Different from the skill-biased technological change approach, Galbraith (2000a) looked into this problem at a more macro economic level, pointing out the existence of a relationship among technological change, economic growth, unemployment, and wage inequalities. On the relationship between technology and wage inequalities, he observed that the technology-supplying industries can reasonably be described as something of a

transient monopoly. They extract income from purchasers of technologies and then redistribute the income to the sellers thereof. Since the buyers in these markets inevitably outnumber the sellers, and since income levels are higher among technology producers than among technology consumers, high levels of business investments in technological innovations generally unequalize the structure of the wage and income.

In spite of some empirical case studies that demonstrate the relationship between IT adoption and wage disparities, the skill-biased technological change approach often fails to examine the issue at a macro level. The neglect of industrial causes at a higher level repeatedly tends to detract from the explanatory power of this approach, giving opportunities to its opponents to question such thinking as technological determinism.

Researchers who take the above three approaches tend to believe that the most direct and effective way to reduce wage inequality would be to reduce the disparity in skills and knowledge between workers. Thus, increased investment in education, skills development, and working knowledge acquisition could not only make the labor market more equal but could also yield additional benefits to workers' productivity and also a country's competitiveness (Steelman & Weinberg, 2005).

Macroeconomic and political economic factors

In contrast to the approach described above, critical economic and political economic scholars point out that depending on education and skills investment to cure the enlarging wage discrepancy in an information economy is in correspondence with the free market purists' propensity to turn the responsibility from structural and power reasons to isolated individuals for education results in a mixture of personal choice and capacity. Second, the idea that education could change the economic and labor market structure or cure the problems of an economic structure is impractical because the function direction is just the opposite. And third, the empirical data show that, although

the education gap between workers has been reduced through government efforts, the wage inequality continues to grow (Galbraith, 2000a). This approach asserts that political action, and the resulting government policy, is the actual determinant influencing the changing trend of wage distribution in an information economy. These political choices might influence and change economic institutions, structures, and policies. Some scholars attribute these political choices more precisely to Neo-liberalism[20] and its related factors: deregulation, globalization, privatization, institutional and wage norm shifting, reduction in social welfare and stagnant minimum wages, liberal economic and monetary policies (such as tolerating unemployment), and so on (Freeman, 1999; Galbraith, 2000a; Harvey, 2005; Howell, 2002; Moran, 1999). They argue that the post-1980 ascendance of neo-liberalist practices and doctrines in many developed countries marks a paradigm change in the world's economic distribution, mainly through enlarging the earning gaps between the rich and the poor. According to this school of thinking, information technologies, informatization, informationalism, and even a boom in information or knowledge, are viewed as tools or results of predominant and pervasive neo-liberalist practices (Harvey, 2005).

Another point of view is that information industries, especially some high-tech industries, gained monopoly profits or tariff rebates and financial support from government policies (such was the case for some NICs) and thus enjoyed higher profits to share with their employees, which caused a biased wage distribution in the labor market (Galbraith, 2000a). For these scholars, political, economic, market, and industrial practices should play the principal role in influencing imformatization and thus the new labor market conditions, not the reverse. In the following section, we will discuss in more detail some of the political economic factors that impact wage distribution.

[20] Neoliberalism is a political economy movement that embraces economic liberalism, for example, the free market, as a means of promoting economic development. This movement is often described as an effort to revert the classical liberalism economic policies in the 18th and 19th Centuries (Portes, 1997).

1. Politics and government's influence on wage trends

Focusing on politics, Hansen (2006), using the U.S. as an example, reported that since 1970, the major factors that reduced labor cost and deepened wage inequality were political, for instance, the increasing Republican and conservative influence in the state, the interstate competition in the American federal system, and American federalism. Galbraith's research (2000a) notes how government support for R&D can be contributory to wage inequality. Government R&D and export assistance helps American companies penetrate foreign markets through increasing their market share, improving their technological competitiveness and enabling them to pay higher wages. Thus, the main beneficiaries of these policies in the technological revolution are the non-production workers in the technology-generating firms. Already comparatively well paid, they are in fact the primary direct beneficiaries of government support for technological change, which further reinforces the wage disparity.

2. Macroeconomic policies and wage trends

Focusing on macroeconomic policies, Galbraith's research on the U.S. (2000c) suggests that the primary reasons for rising inequalities are unemployment, the foreign exchange rate, high interest rates, and debt peonage, all of which are linked to the structure of policy-making delegated to the Federal Reserve, which plays a particularly decisive role when it comes to policies of stabilization and inflation control. Furthermore, the retreat of state policy protections of low-wage, less educated, more vulnerable workers by a stable macroeconomic policy also changed the labor market conditions in the information economy age. From 1945 through 1970 in the U.S., the state maintained a wide range of protections for low-level workers. As a result, a broadly equal pattern of social progress was sustained despite rapid technological change in those years. These protections were held in place by a stable macroeconomic policy that helped avoid sharp or prolonged disruptions in economic growth and, in particular, was supported by a

monetary policy that was subordinated to these larger objectives. In those years, the government as a whole was committed to the pursuit of full employment, price stability, and high rates of economic growth. After 1970, the technological change continued, but the protections were withdrawn; meanwhile macroeconomic policy became much more unstable. The state shifted its support from the economy in general, that is, the macro economy, to certain leading sectors of the economy, and in particular, to some firms and industries most devoted to technological change. Moreover, the ever increasing acceleration of globalization and the relentless drive for efficiency inherently tended to redistribute income only in favor of smaller numbers of workers (Galbraith, 2000a). Equally disconcerting is the policy on the minimum wage—Blanchflower and Slaughter (1999) pointed out that the fall in the inflation-adjusted minimum wage has led to rising inequalities in the U.S. and the U.K. since 1970.

3. Trade union and wage trends

Furthermore, the waning of trade unions has also deteriorated the wage disparity. Unions typically reduce income inequalities among their members through standardizing pay among workers within establishments and through equalizing pay across establishments. They reduce income inequalities between high- and low-paid workers by raising the pay and benefits of their largely blue-collar private sector members closer to that of higher-paid executives and professionals. They also reduce inequalities in non-union firms by inducing those firms to raise pay or benefits to avoid unionization. Studies suggest that about one-fifth of the rise in inequalities is due to the decline of unions (Freeman, 1999). Howell (2002) proposed a hypothesis about the shifting wage norms: a systematic and successful assault on the wage standard by business management, reinforced by public policies, leads to the decline of the unions, wage concessions, plant relocation, outsourcing, and greater reliance on contingent workers. For Howell, both traditional wage-setting institutions and middle-class jobs are in decline simultaneously.

Howell's hypothesis suggests a potentially unified, secular alternative to the Kuznets hypothesis: variations in the structured wage setting arrangements lead to income distribution changes. Likewise, Fortin and Lemieux (1996) demonstrated that one-third of the total increase in the U.S. wage inequality in the 1980s can be attributed to declines in unionization and the real minimum wage along with economic deregulations.

4. Globalization, trade, and wage trends

Blanchflower and Slaughter (1999) further pointed to globalization as a vital influence on informatization and the labor market. First, firms adopt information technology in order to remain internationally competitive by cutting labor costs. Second, firms secure more power in bargaining against unions with threats to introduce foreign factors of production (via foreign direct investment or outsourcing to foreign suppliers) with the help of information technologies, which lend critical global mobility to production factors.

A case study of the U.S., conducted by Bernard and Jensen (1997), found that there is a positive correlation between export, technology use, and the wage disparity. According to them, large plants are more capital-intensive and productive, and more likely to adopt advanced technologies, to export, and to pay higher wages. Unfortunately, which of these characteristics is the cause of the others is not clear from the study. Although their research results indicate that between-plant movement and wages to exporters play a significant role in increasing relative wages of non-production workers, Bernard and Jensen remind us that neither trade nor technology alone can fully account for the observed changes in the dispersion of the wage. Similarly, Jensen and Troske (1999) also suggested that to make further progress in identifying the sources of increasing wage dispersion, a better understanding of the underlying relationships among technology, the composition of the workforce, and a firm’s marketing and export strategies is required.

With a more specific focus on trade, Moran (1999) indicated two ways in which trade (investment) might influence the trend in the change of wage. The first is sometimes known as the great-sucking-sound hypothesis: outward investment could hamstring the domestic economy by continuously shifting good jobs abroad and leaving behind only a few low-wage, low-benefit employment opportunities at home. The second is sometimes referred to as the siphoning-off-the-good-jobs hypothesis: inward investment could significantly boost productive activities, disassembling/reassembling the resulting operations in a way that diverts high-wage, high-benefit jobs to the home countries of parent firms while consigning only a few low-wage, low benefit jobs to the host economy. For example, scholars compared the US and Swedish multinational companies, finding that the US multinational companies tended to invest and move their lower skill, labor intensive sectors to developing countries and NICs, which reduced the US blue-collar workers' employment and enlarged the income disparity. In contrast, Swedish multinational companies tended to invest in both developed and developing countries. They moved the knowledge-intensive sectors to developed countries and hired more blue-collar workers in the home country, thus dropping the wage disparity in the home country; as for investment in developing countries, surprisingly, it contributed to the employment of both blue-collar and white collar workers in Sweden, and no obvious deterioration for wage disparity was found (Blomstrom, Fors, & Lipsey, 1997).

Using Taiwanese companies' outward investment to China's as an example, Liu (2006) pointed out that Taiwanese companies primarily moved out the lower skill, labor-intensive sectors to China, which lowered Taiwan's total employment, especially that of the lower skill workers, thus deteriorating Taiwan's wage inequality.

5. Immigrant workers and wage trends

As to immigrants or immigrant workers, it is commonly believed that they have skewed the income distribution toward the bottom of the labor market by enlarging the

number of workers in the lowest-paying jobs. For Camarata and Krikorian (1999), in the case of immigrant workers, the losers are more likely to be the working poor and those with less skills. These workers are the most negatively influenced for they tend to be employed in the sections of the labor market where immigrant workers are highly concentrated. As for the winners, they are most likely those middle and upper class workers, whose skills tend to complement those of immigrant workers.

However, there are still some doubts regarding the above viewpoint. Freeman (1999) argued that, according to the his research and that of his colleagues, the increased flow of low-skill immigrants is not the reason for declining wages for less skilled workers in the case of Americans. As he pointed out, the majority of immigrant workers have less than a grade school education and are more likely to complement the work of most Americans than to compete with them in the job market. In addition, the high proportion of the rise of wage-earning inequality in the U.S. is found among workers with similar skills, including those workers who should not be affected by less skilled immigrant workers such as mechanics or lawyers.

Overall, this dissertation is based on the assumption that the labor market changes in an information economy should not result from one single powerful determinant; instead, they should be influenced by various and complicated interactions among numerous different political, economic, or technological factors, possibly including application of technologies (for instance, informatization), industrial characteristics, government policies, institutional reason (such as labor union), the role of interest and social groups, trade and globalization, as well as international political economy factors and structure.

To summarize, among the arguments for reasons accounting for information economy's role in increasing economic inequality, we can generally categorize them into three main approaches, information/knowledge/informationalism, information technology determinism, and also the political-economic perspective. These three different

approaches also tend to adopt different policy attitudes regarding the raised labor market problem such as unemployment or economic inequality. The first two approaches tend to consider those labor market changes is an inevitable tendency along with humans' social, technological, and production progresses. And they more often seek individuals to solve their own competitive ability problems by pursuing more education or job training. In contrast, the approach relying on political economic reasons tends to believe that the labor market changes are results of policy choices, which are determined by the political and economic power or the interaction between them. Thus, to fix the labor market problems raised by policy choices, people should certainly look back to the policies themselves. This dissertation wants to clarify these arguments and also to examine these issues outside the developed countries, which is still very rare so far in empirical research.

THE HISTORY OF TAIWAN'S ECONOMIC INEQUALITY

Observing Taiwan's economic inequality, we can see a mild U pattern, with fairly rapid decline in inequality until the late 1970s-early 1980s, followed by rises offsetting more than half of the earlier fall. Generally speaking, income inequality was very high between the end of World War II and 1950; then slowly decreased in the 1950s, dropped dramatically in the 1960s, and reached its historical bottom in the 1970s. After that, however, it went back up along with the economic transformation, namely the decline of labor-intensive manufacturing and the boom of information-intensive industries.

If we go more specifically stage by stage, the period from 1945 to 1952 was a period when Taiwan was recovering from World War II and from the civil war between the Kuomintang Party (KMT) and the Chinese Communist Party. This period of time was characterized by high inflation and serious economic inequality, which was considerably high at this time due to the country's unstable economic condition (Cornia, 2000). To

solve this problem and to maintain social and political stability, the KMT government emphasized the importance of taking care of the poor by adopting policies such as land reform to redistribute wealth and to lower the economic inequality (Yu, 2004).

From 1953 to 1960, Taiwan's government was devoted to light industrial development. The central industries were supported by the government in order to meet various domestic needs such as textiles, food, electric appliances, and chemical products. These light industries rapidly expanded employment to both well-educated and low-skilled workers, effectively helping economic inequality decline little by little.

The period from 1961 to 1972 was the golden age for Taiwan's labor-intensive manufacturing, during which the country completed its export-oriented industrialization and successfully emerged as one of the most important production sites for the American and Japanese markets (Ho & Lo, 2002; C. F. Lin, 2004b). This stage was also an important turning point for Taiwan's economy as it changed from being based on agriculture to relying mainly on manufacturing. Representative industries at this stage included textiles, leather and fur, foodstuffs and the glass industry. Due to the mass employment offered by the labor-intensive manufacturing industries, economic inequality and the Gini coefficient were sharply reduced from 0.321 to 0.291 (Cornia, 2000; "Directorate for General Budget, Accounting, and Statistics ").

The decade 1973 to 1983 was the period when Taiwan's heavy chemical industries developed. Nevertheless, labor-intensive manufacturing still accounted for the lion's share of the total GDP. Economic inequality at this time hit its historically lowest point in 1976 at a Gini coefficient of 0.280, and then gradually increased to 0.287 with the gradual decline of-labor intensive manufacturing (Cornia, 2000; "Directorate for General Budget, Accounting, and Statistics ").

The period between 1984 and 1990, the economic liberalization stage, has also been recognized as an early-stage in Taiwan's transition to an information economy (Ho & Lo, 2002; C. F. Lin, 2004b). During this time, Taiwan's labor-intensive manufacturing

confronted increasing international competition from other NICs and developing countries (Ranis, 1992). In addition, enormous pressure from the U.S. seeking the liberalization of Taiwan's domestic market, pushed the government to adopt a more liberal and open attitude concerning economic policies. The New Taiwanese Dollar appreciated sharply, tariff duties were lowered, labor costs rapidly grew, and Taiwan quickly lost its competitive advantage in laborintensive manufacturing (T. J. Chen & Ku, 1995). Industrial production dropped greatly at this time, and unemployment became a serious problem (Chu, 2003d). To sustain Taiwan's economy, the government began promoting high technology and information-intensive industries to replace traditional labor-intensive industries. At this point, the service industry for the first time surpassed manufacturing to become the largest contributor to GDP and to the employment of the labor force ("National Statistics Database," 2007). However, this paradigm shift from labor-intensive manufacturing to information-intensive industries and service industries was accompanied by a striking increase in wage inequality. The Gini coefficient rose from 0.287 to 0.312 (Cornia, 2000; "Directorate for General Budget, Accounting, and Statistics "). Reasons for this rise in inequality were attributed to the industrial transformation and its consequent increasing unemployment as well as to the increase in globalization and liberal market policies.

The 1990s, "the age of high-tech industry," witnessed fast development in Taiwan's informatization and the emerging information economy. At this time, Taiwan's IT production began to claim a lion's share of the whole world's market. Moreover, under the pressure of domestic enterprises, the government removed restrictions on immigrant workers in 1991 so as to lower labor costs. As a result of industrial transformation and immigrant worker policies, Taiwan's unemployment rate surged and the inequality of its income distribution deepened. Unemployment rose from 1.67 to 2.99% and the Gini coefficient grew from 0.312 to 0.326 ("Directorate for General Budget, Accounting, and Statistics ").

From the year 2000 to the present, the Taiwanese government has been engaged in developing knowledge-intensive industries (T. J. Chen & Lee, 2004b), with Taiwan's IT industry playing a crucial role in global IT production. However, the highly reliance on export of information products has sometimes been problematic. In 2001, the world's IT industry suffered from a severe recession; Taiwan had its first historical economic negative growth (-2%), and the unemployment rate and wage inequality both hit an all-time high. Since 2003, while economic growth has gradually climbed back to normal and Taiwan's GDP growth rate has returned back to around 4-5%, the unemployment rate and wage inequality have still remained at a much higher level than before. During this period, unemployment hit the highest point in Taiwan's history at 5.17% in 2002 and the Gini coefficient also set a historical record at 0.35 in 2001. Therefore, this knowledge economy is also characterized by the highest unemployment rate and highest income inequality in Taiwan's history ("National Statistics Database," 2007).

RELEVANT RESEARCH ON ECONOMIC INEQUALITY IN TAIWAN

Taiwan was generally believed to be an astonishing example of high-speed economic growth and very equal income distribution, especially in the 1960s and 70s. While after 1980 when the income inequality was worsening, it was still much milder than in other developed and developing countries (Amsden, 1985; Wade, 1990). If this was true, what were reasons for Taiwan's change toward greater economic inequality, especially after 1980? In reference to Taiwan's wage inequality, Vere (2005) pointed out that education and technical changes such as informatization and automation within manufacturing industries were the primary forces shaping Taiwan's wage inequality in the 1980s and 1990s respectively. In his study, education expansion in the 1980s helped reduce Taiwan's wage inequality; however, the technical changes in the 1990s, in contrast, increased the wage disparity. Other social factors such as age and gender,

according to Vere's research, have had much less impact on wage inequality in the last three decades.

Cornia (2000) also observed Taiwan's economic development and inequality, coming to a conclusion that, after 1983, the development of skill/information intensive sectors did increase wage inequality but other reasons leading to increasing income inequality included the development of large corporations and escalation in land prices, especially between 1983 and 1993, a time of growing land speculation trends.

Drawing from "the Economic Yearbook of the Republic of China, 2005" (*Economic yearbook of the Republic of China*, 2006), the high-tech and information industries are believed to have contributed to the increasing wage distance between themselves and other industries, which was believed to be one of the most important reasons for Taiwan's high economic inequality.

Liou (2001) analyzed the influence of industrial structural transformation on income distribution in Taiwan from 1991 to 1996, finding the industrial transition from traditional labor-intensive manufacturing to information, electronics, and service has made the gap between high wage and low wage continue to enlarge. The reason for this, according to him, was that the returns of those new information-intensive industries continued growing, and the workers in these industries were able to share the benefits of this growth by receiving higher payment, which caused the growth of total income disparity. In addition, the wage polarization among workers with different skill levels also increased for the reason that the dominant new information industries tended to hire more skilled or knowledgable workers. Analyzing this issue from an occupational perspective, he claimed that the wage disparity among groups of managers, professionals, and associate professionals enlarged and that among groups of machine operators and physical labor it declined; the result was that the final total wage disparity increased. Furthermore, like Cornia, Liou observed that the trend towards larger corporations contributed to the effects on inequality as well. Unlike the previous labor-intensive

manufacturing stage, when small and middle sized enterprises dominated the production activities and the businesses profits and income distribution were all more even, the development of large corporations accelerated the rapid growth of unequal income distribution.

Chuan (2006) investigated the relationship between information economies and inequality by analyzing the percentage share of income by percentile group of households. He noted that the highest income group benefited from the industrial transformation to an information economy because of their higher quality human capital and skills; however, the lowest and second lowest groups suffered remarkably from structural unemployment as they could not promptly obtain the skills needed to meet the skill requirements of high technology and information industries. As a result, the income gap between higher and lower income groups kept enlarging.

Tsai (M. C. Tsai, 2005) also argued that the transformation to an information economy has widened Taiwan's income gap, as the information-intensive industries tend to hire more higher-skilled workers and fewer domestic blue-collar workers, thereby increasing the wages of professional workers.

In a similar vein, Yu (Yu, 2004) concluded that an information or knowledge economy has widened the income and wage gap in Taiwan for two reasons: first, enterprises in the electronics and information industries can accumulate massive amounts of money in a very short period of time, merely because their share prices can multiply several-fold overnight; and second, people who have become very well educated in the field of information technology tend to enjoy much higher salaries, while those with lower levels of information technology education often find themselves with no jobs at all.

Likewise, by constructing a survey targeting 1,000 Taiwanese companies, Han (2001) observed that companies adopting high-level information technologies such as computer-integrated manufacturing or computer-integrated businesses, tend to pay higher

salaries for higher skilled workers as automation and information-intensive technologies increase the complexity of jobs and require higher labor skills. Han's research shows that the adoption of information-intensive technologies has had a significant and highly positive relationship with higher salaries.

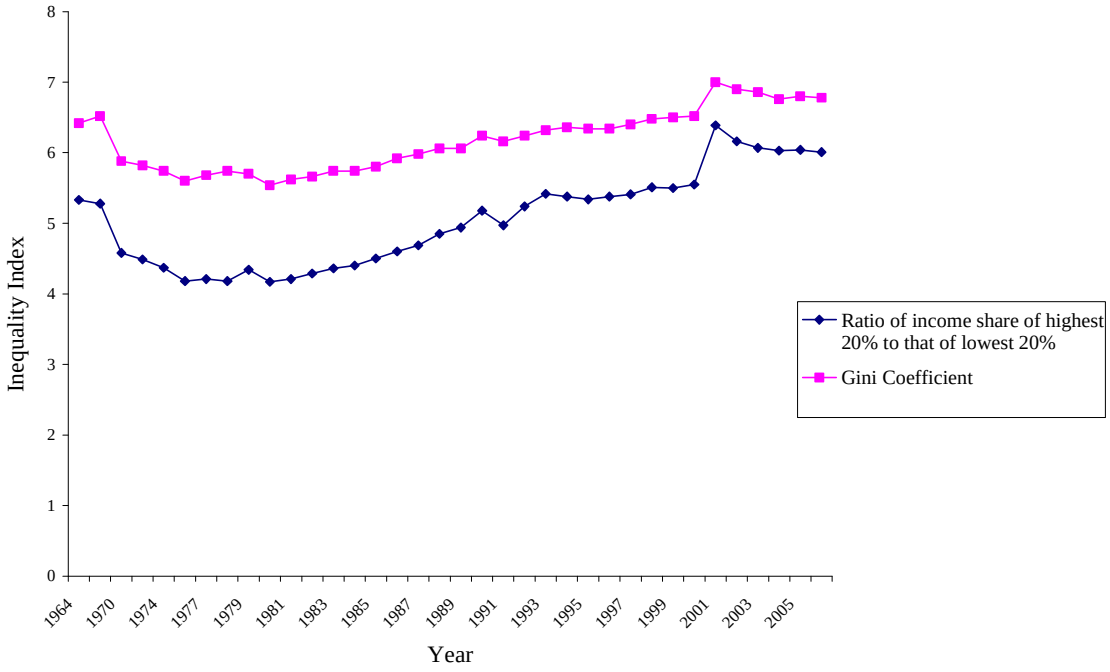
However, comprehensive, systematic, and empirical research on this issue from a macroeconomic perspective is still lacking in Taiwan. Moreover, the impacts of state policy and other political economic reasons are often overlooked in these research studies. Therefore, this dissertation is expected to narrow this gap by tracking the influence of more political economic reasons on Taiwan's labor market changes after the information economy transformation.

TRENDS IN TAIWAN'S ECONOMIC INEQUALITY

After reviewing the relevant research regarding the reasons for Taiwan's changing economic inequality, now we are going to investigate the actual tendencies of Taiwan's economic inequality and pose the question of whether Taiwan's trends in economic distribution have been similar to other countries with information economies.

There are three most commonly used indices for measuring a society's economic inequality, including: the Gini Coefficient, Percentage Share of Disposable Income by Percentile Group of Households, and the Theil's Inequality Index. Figure 20 shows the trends in the Gini Coefficient and the ratio of income share of highest 20% to that of lowest 20% (or the Percentage Share of Disposable Income by Percentile Group of Households). These two indices have high consistency. From these figures, we indeed can see that, after economic inequality reached a historical low around 1977, the income inequality continued to grow with the decline of labor-intensive manufacturing and the growth of information-intensive industries. In 2001, the inequality index hit a historical high because of the worldwide IT industry recession. This reveals that Taiwan's

economic situation, particularly its income inequality, has become fairly sensitive to and influenced by information industries, both domestic and overseas. However, while the Gini Coefficient and Percentage Share of Disposable Income by Percentile Group of Households tell us about trends in Taiwan's income inequality, they are not able to show the sources or even reasons for this increasing inequality. In addition, they both use household income as the base data source, which might not directly reflect the labor market situation or the wage distribution, but could also incorporate other influences such as income from stocks, rent, capital, and the like. Hence, this study included the application of the Theil statistics, which can focus only on wages and also can show us the sources of inequality.



Source: Directorate-General of Budget, Accounting, and Statistics, R.O.C.

Figure 20. Trends in Taiwan's economic inequality, 1964-2005

Here the dissertation presents the calculation of a single annual index of inequality in the wage structure using the lower-bound, between-group estimate of

Theil's T statistics (T´) as the required data for calculating within-group inequality—the individual wage data were usually not available (please refer to Appendix A to see how the Theil's T was calculated). For a group structure, this research used wage and employment data from the main employment sectors in Taiwan. Thus, the main sectors the paper analyzed include manufacturing; mining and quarrying; electricity, gas and water; construction; trade; transportation and telecommunication; finance and insurance; real estate, rental and leasing; accommodation and food services; professional, science and technical services; health care; cultural, sporting and recreational services; and other services. Sectors such as agriculture are not included because they still belong to an unofficial employment sector in Taiwan and do not have wage and employment data available. The raw data come from measures and survey data gathered by the Taiwanese government, mainly from the Directorate-General of Budget, Accounting, and Statistics, Executive Yuan, Republic of China (the GBAS). The group-wise decomposability of Theil's statistic measure of inequality permits us to use these data to compute an estimate of the evolution of inequality in the wage structure over time. It produces a measure of changing relative wage dispersion that is weighted by the relative size of the working population in each of the underlying classes of economic activity (Berner & Galbraith, 2001; Conceição & Ferreira, 2000; Ferguson & Galbraith, 2001).

The formula used to calculate Theil' s statistics of income inequality is shown below, which is composed of between-group inequality (T ´) plus within-group inequality (T_w) (Conceição & Galbraith, 2001, pp. 264-267). If we consider that the population is divided into m industry groups, g_1, g_2 , …. g_m, each with n_j individuals, $j = 1,\ldots,m$, then the decomposition takes the self-similar form of a fractal:

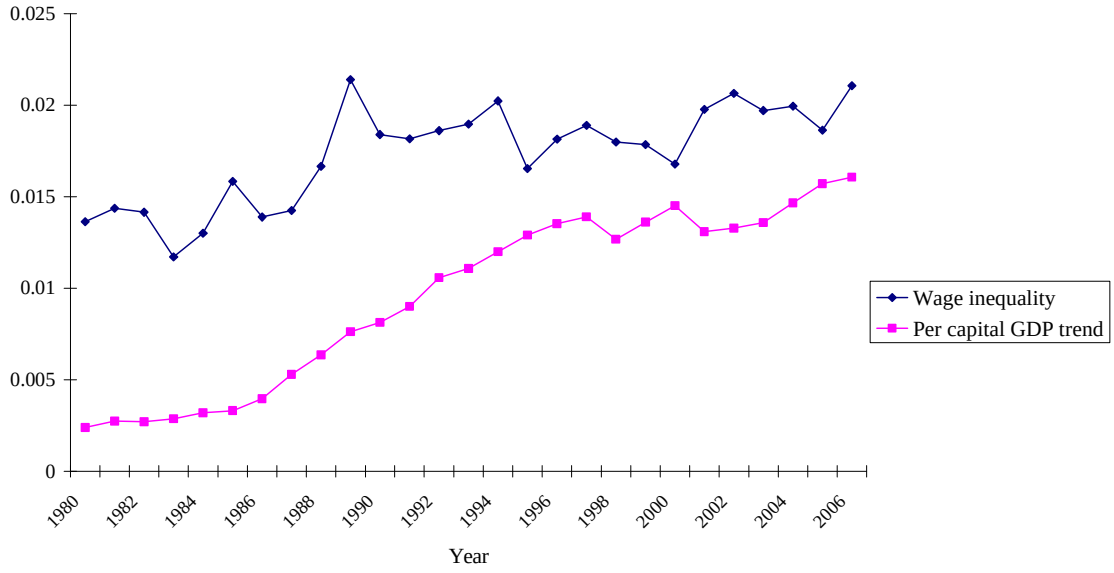
$$\begin{cases} T = \sum_{j=1}^{m} pjRj \log Rj + \sum_{j=1}^{m} pjRjTj \\ T_j = \frac{1}{nj} \sum_{i \in gj} ri \log ri \end{cases} \quad (1)$$

The employment proportion in each group is represented by $p_j = \frac{n_j}{n}$. The ratio of average group income to overall average income is $R_j = \frac{\mu_j}{\mu}$. And the ratio between individual income (y_i) and average income (μ_Y) is represented by γ_i. In this equation, n represents employment, μ represents average income, and j represents a subscript denoting the group.

The lower-bound, between-group estimate of Theil's T statistics, T´ formula is as follows:

$$T' = \sum_{j=1}^{m} p_j R_j \log R_j \qquad (2)$$

Figure 21 shows the results of the wage inequality calculations (calculated by equation 2).



Source: The author's calculations based on the GBAS data

Figure 21. Wage inequality between major sectors, 1980-2006

As we can see from Figure 21, wage inequality within the economic sector has increased unevenly since 1980, the earliest year with a complete set of available data.

From 1980 to 2006, wage inequality increased strikingly from 0.0136 to 0.0189, reaching its two highest points in 1989 and 2006. The dramatic increase of wage inequality in the 1980s was due to the first wave of labor-intensive manufacturing moving out of Taiwan (a majority moving to South East Asia) and the sudden wave of speculation activities in the real estate industry and finance market (which were responsible for the inequality peak in 1989) as well as a series of liberalization, globalization, and open market policies initiated by the government (C.L. Tsay, 1995). The 1995 peak was due to the second wave of labor-intensive manufacturing moving out (mainly to China), and at this time, information industries for the first time replaced labor-intensive manufacturing to become the dominant industry in Taiwan. Therefore, after the first half of the 1990s, the increase of wage inequality is generally attributed to Taiwan's industrial transformation from labor-intensive manufacturing to information-intensive industries (Chu, 2003d). In order to prove this, we need to further analyze the sources of these inequalities.

SOURCES OF TAIWAN'S ECONOMIC INEQUALITY AFTER 1984

As mentioned earlier, the Theil statistics can show us the sources of wage inequality, which the Gini Coefficient and Percentage Share of Disposable Income by Percentile Group of Households cannot do. Based on the computation of data of total employment and total payroll by industrial category, the lower bound between-group estimate of Theil's T statistics can easily reveal which industries are the main contributors to inequality.

Table 7 and Figure 22 provide evidence of the sources of wage inequality in manufacturing—the particular pattern of manufacturing industry-specific wage gains and losses in Taiwan between 1979 and 2006. Each number in Table 7 represents the Theil element of each year or weighted contribution in relation to the overall inequality of each manufacturing industry in that year. As shown in Table 7 and Figure 22, industries whose

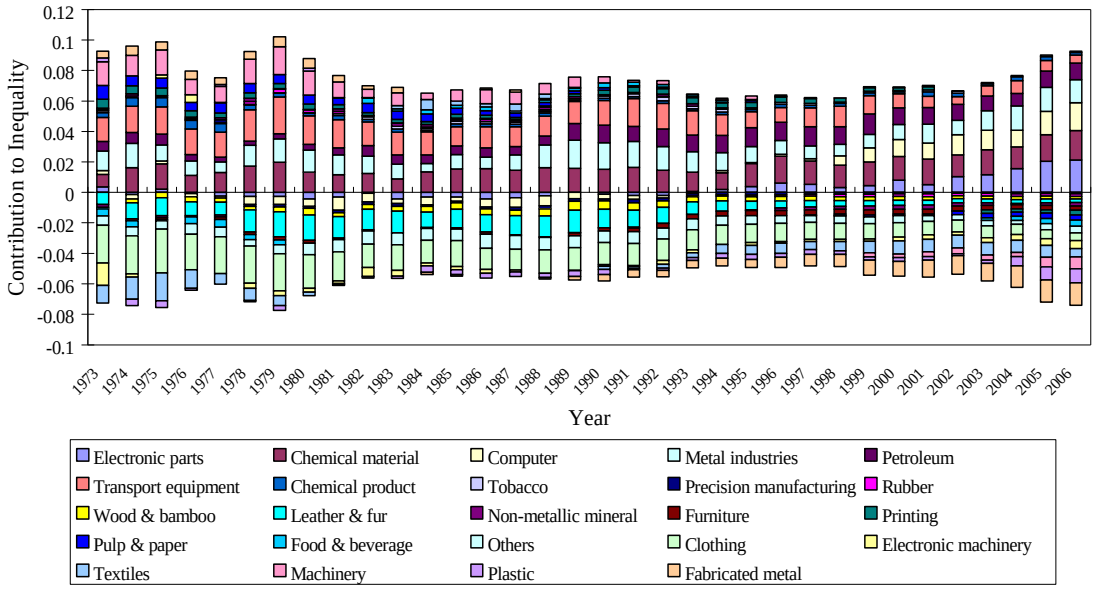
average income is above the total average had a positive value in relation to the overall inequality, while those whose average income was below the total average had a negative value. For research purposes, the paper calculated the Theil elements of all categorized manufacturing industries from 1979 to 2006, but Table 7 represents only ten years of data including only the first and last six industries (the first six positive contributors are above the black line in the Table ; the six most negative contributors are below the black line). From Table 7 and Figure 22, we can see that computers and electronic parts, two important and representative industries of information-intensive manufacturing, appear to be two of the main positive manufacturing contributors to the gradual increase in wage inequality in Taiwan since 1994. For example, in 2006, the electronic parts industry was the highest contributor to wage inequality, at 0.0213, and the computer industry was the third highest contributor, at 0.0184. Note that the second and the fourth highest wage inequality contributors--chemical materials and the metal industries--provided long-term support for other industries' material needs and had a more immediate influence on wage inequality than that of the computer and electronic part industries. However, they have been highly relevant to IT industry development in recent years and can also be claimed as belonging to the information industry sector in the last two decades. Furthermore, at about the same time, the below-average wage earners in the manufacturing sector include industries such as leather and fur, clothing, textiles, machinery, plastics, and fabricated metal products--most of which are primarily categorized into the traditional labor-intensive (as opposed to information and technique intensive) manufacturing. The most obvious example, the clothing industry, had a crucial influence on wage inequality before the 1980s. For example, in 1975, its contribution to wage inequality was -0.029, and this influence was still apparent during the 1980s although it eventually began to decline. However, after the 1990s, especially after the year 2000, its effect on Taiwan's wage inequality almost disappeared with its industrial base moving out of Taiwan; for example, in 2006, the contribution of the clothing industry to wage inequality was only -0.005. A

similar example is the leather and fur industry. From the previous calculations and data, we indeed find that information-intensive manufacturing industries such as ICT industries, have been gradually replacing other industries, becoming significant wage earners and the primary contributors to wage polarization in Taiwan.

Table 5. Theil Elements, by manufacturing sector

	1979	1982	1985	1988	1991	1994	1997	2000	2003	2006
Electronic parts	-0.0027	-0.0005	-0.003	-0.002	-0.002	0.002	0.0019	0.0081	0.0117	0.0213
Chemical material	0.0199	0.0123	0.0154	0.0163	0.0165	0.011	0.0111	0.0155	0.0162	0.0193
Computer	-0.0052	-0.0058	-0.003	-0.006	-0.0026	0.001	0.0013	0.011	0.0129	0.0184
Metal industry	0.0153	0.0116	0.0093	0.0149	0.0168	0.012	0.0119	0.01	0.0128	0.0152
Petroleum	0.0034	0.0069	0.0058	0.0059	0.0101	0.011	0.0113	0.011	0.0098	0.0108
Transport equipment	0.024	0.0154	0.0127	0.013	0.0183	0.014	0.0137	0.0091	0.0067	0.0053
Leather & fur	-0.0164	-0.0134	-0.012	-0.014	-0.0112	-0.007	-0.007	-0.003	-0.003	-0.0021
Clothing	-0.0243	-0.0152	-0.017	-0.015	-0.0144	-0.013	-0.013	-0.009	-0.008	-0.0051
Textiles	-0.0064	0.0004	0.0027	0.0029	-0.0013	-0.006	-0.006	-0.009	-0.008	-0.0055
Machinery	0.0184	0.0055	0.0074	0.007	0.0013	1E-03	0.001	-0.002	-0.003	-0.0077
Plastic	-0.0031	-0.0009	-0.003	-0.003	-0.0008	-0.003	-0.003	-0.003	-0.002	-0.0091
Fabricated metal	0.0065	0.0021	-1E-03	-9E-04	-0.0049	-0.005	-0.005	-0.01	-0.011	-0.0147

Source: The author's calculations based on the GBAS data



Source: The author's calculations based on GBAS data

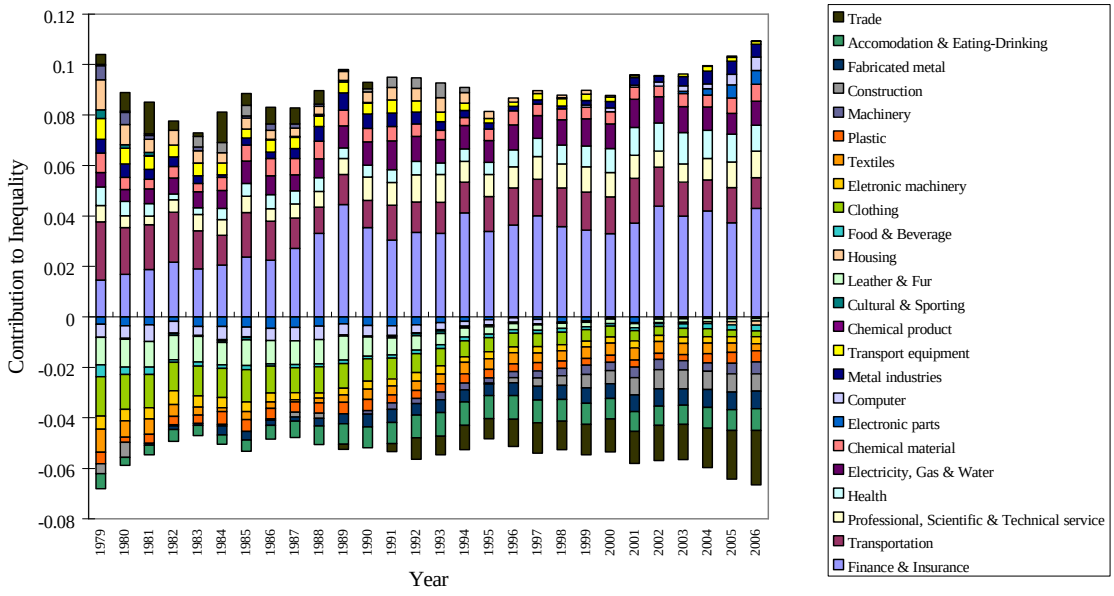
Figure 22. Theil elements- by manufacturing sectors, 1973-2006

If we extend this analysis to all representative industries in Taiwan, as Table 8 and Figure 23 show, among the first eight contributors, information-intensive industries (including both service and manufacturing) account for seven of the industries that have affected Taiwan's wage inequality (finance & insurance; transportation; electronic parts & computers; professional, scientific & technical services; health; chemical materials), the eighth is the state-owned monopoly industry: electricity, gas & water. The financial sector stands out as having generated the largest wage inequality since 1982, and its Theil element in 2006 reached as high as 0.043. Finance is not only the most important industry of the information-intensive service sector, but it is also one of the most computerized and informationalized industries in Taiwan. Moreover, if we combine the computer and electronic parts industries, they would rank third in contributing to increasing wage inequality, ranking just above another information-intensive industry, transportation and telecommunication. Another industry worth noting is professional, scientific & technical services. Its contribution to total wage inequality has also appeared to be crucial, beginning around the 1990s. In regards to the below-average wage earners, the trade and accommodation industries--both labor-intensive service industries—have suffered since 1993. Similarly, traditional labor-intensive industries such as fabricated metal products, construction, textiles, plastic products, and the clothing industry have also had a negative impact on wage equality. Again, we can observe the diminishing importance of clothing, leather and fur industries' impact on wage inequality since the 1970s while the trade industry has become a much more critical player, especially after 1991.

Table 6. Theil Elements, by main industries in service and manufacturing

	1979	1982	1985	1988	1991	1994	1997	2000	2003	2006
Finance & Insurance	0.0146	0.0217	0.0237	0.0332	0.0305	0.0412	0.0401	0.0329	0.04	0.043
Transportation & Telecom	0.0231	0.0198	0.0177	0.0104	0.0138	0.0122	0.0144	0.0146	0.0135	0.0122
Professional & Technical service	0.0064	0.0049	0.0064	0.0062	0.0089	0.0084	0.009	0.0096	0.0072	0.0106
Health & Medical	0.0074	0.0022	0.0051	0.0054	0.0051	0.0048	0.0071	0.0096	0.0125	0.0103
Electricity, Gas & Water	0.0057	0.0064	0.0089	0.0074	0.0114	0.0093	0.009	0.0098	0.0102	0.0094
Chemical material	0.0077	0.0046	0.0063	0.0069	0.0057	0.0032	0.0047	0.0048	0.0052	0.0068
Electronic parts	-0.0029	-0.0018	-0.004	-0.0036	-0.004	-0.002	-1E-03	-3E-04	0.0009	0.0054
Computer	-0.0052	-0.0047	-0.004	-0.0054	-0.004	-0.002	-0.002	0.0016	0.0022	0.0054
Clothing	-0.0155	-0.0112	-0.013	-0.0104	-0.008	-0.006	-0.005	-0.004	-0.003	-0.0023
Electronic machinery	-0.0052	-0.0055	-0.004	-0.0021	-0.003	-0.002	-0.003	-0.003	-0.003	-0.0028
Textiles	-0.0092	-0.0046	-0.003	-0.0018	-0.004	-0.005	-0.004	-0.005	-0.004	-0.0028
Plastic	-0.0045	-0.0033	-0.005	-0.0041	-0.003	-0.004	-0.003	-0.003	-0.002	-0.0044
Machinery	0.0057	-1E-06	0.0009	0.0009	-0.003	-0.003	-0.003	-0.003	-0.004	-0.0046
Construction	-0.004	-0.0005	0.0042	-0.0021	0.0041	0.002	-0.003	-0.005	-0.008	-0.0069
Fabricated metal	0.0005	-0.0014	-0.003	-0.0031	-0.005	-0.005	-0.005	-0.006	-0.006	-0.0069
Accommodation, Eat-Drinking	-0.0059	-0.0046	-0.004	-0.0072	-0.008	-0.009	-0.009	-0.008	-0.008	-0.0086
Trade	0.0039	0.0036	0.0047	0.0053	-0.003	-0.01	-0.012	-0.013	-0.014	-0.0216

Source: The author's calculations based on GBAS data



Source: The author's calculations based on GBAS data

Figure 23. Theil elements- by main industries in service and manufacturing

From the above observations, we find that the information-intensive industries (including manufacturing and service) such as the industries of finance, transportation and telecommunication, professional services, science and technical services, medical services, electronic parts, and computers have actually become the primary source of Taiwan's increasing wage inequality since 1980. In contrast, industries that are less information-intensive, with a lower level of informatization such as accommodation and food services, clothing, construction, trade, fabricated metal products, and plastic products have become the sectors with the largest below-average contributions to inequality after 1980.

THE LOCI OF INEQUALITY

Now that we have recognized that the source of Taiwan's wage inequality in the last two decades has been due to the industrial transformation from traditional labor-

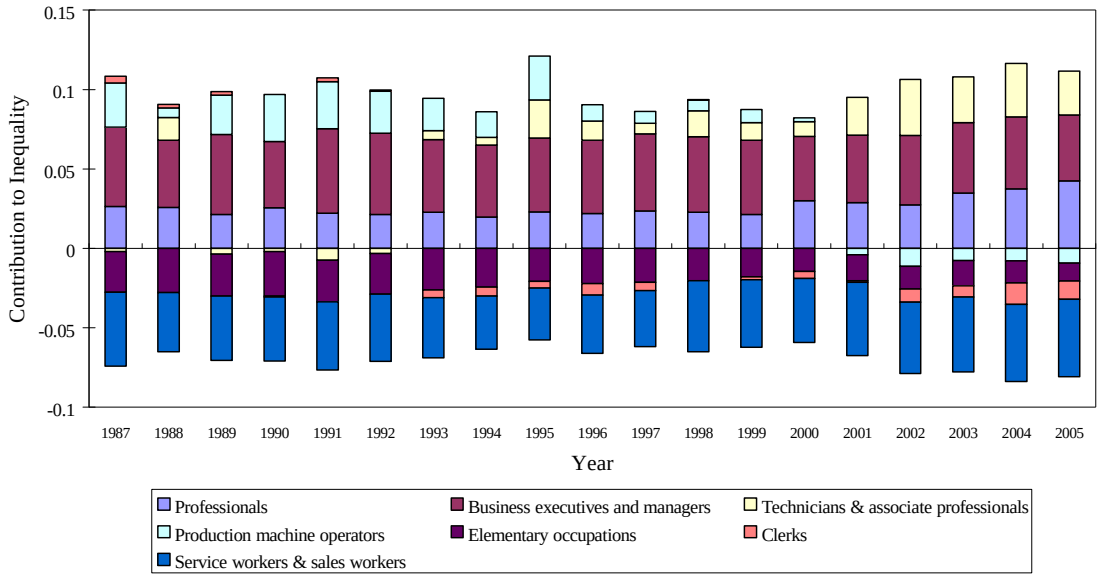
intensive industries to information-intensive industries, we want to track the sectors in which this inequality is located. We are going to discuss this from the perspectives of wages disparities among industries, among occupations, and among different educational levels.

For the wage-changing trends among industries, petroleum was the leading industry with the highest rate of wage increase between 1980 - 2006. The percentage of its average wage in the total industrial wage doubled, increasing by 100.2%. A possible reason for the petroleum industry's wage superiority is due to the limited or decreasing sources and quantity of oil, causing an increase in oil prices as well as an increase in profits for the petroleum industry. The following leading industries also had high rates of wage increase: electronic parts 58.1%, professional, scientific & technical services 33.9%, computers 26.3%, finance & insurance 22.7%, and precision manufacturing 15.0%. The industries whose wage percentage declined included: machinery -38.2%, housing -34.1%, printing -32.4%, furniture -32.0%, pulp & paper -29.9%, accommodation and dining-29.0%. The industries whose wage stayed comparatively stable included: incorporated non-metallic mineral industries 1.1%, trade -2.6%, the food and beverage industry -4.6%, transport equipment 1.2% and textiles -1.9%. Again, we can clearly see an increasing wage trend for information-intensive industries (and the petroleum industry) in the areas of electronic parts, professional services, computer, and finance and insurance; as well as a declining trend for traditional labor-intensive industries and service industries that are less information intensive such as machinery, printing, furniture, pulp & paper, and housing. These trends resulted in growing wage disparities among workers in different industries and thus contributed to Taiwan's increasing wage inequality after the 1980s. Now, however, we need to look at additional perspectives on wage trends such as the wage changes among occupations.

The following paragraphs examine the issue of economic inequality based on occupation, using the economic argument that in an information society or economy,

workers with higher skills and knowledge enjoy higher salaries while their contribution to wage inequality keeps increasing.

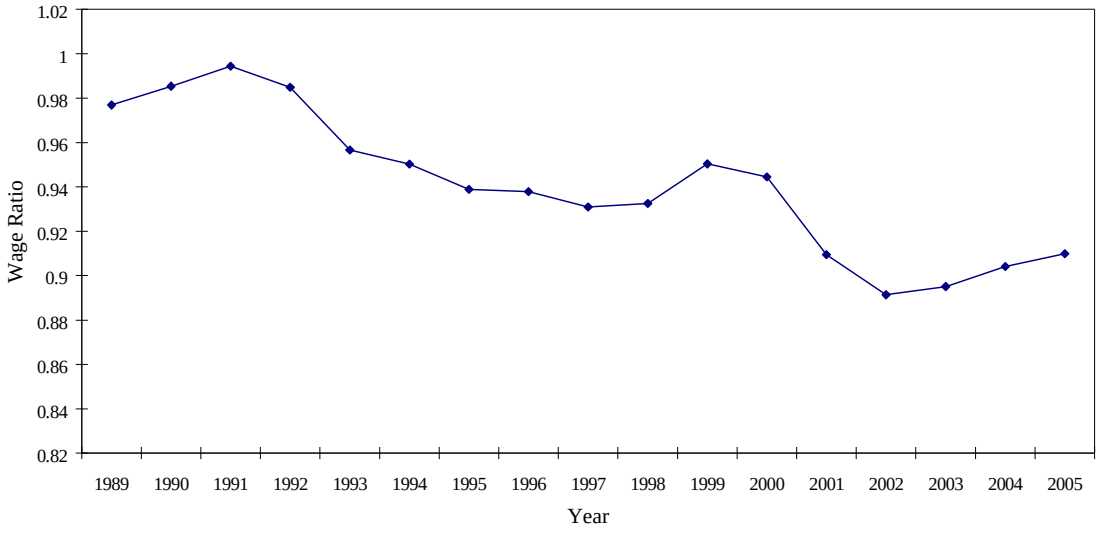
In Figure 24, we can see that since the 1990s, production machine operators started losing their earning advantage and became below-average earners by 2001; in contrast, technicians and associate professionals largely replaced machine operators, increasing their wage privilege since 1993, and therefore, contributing to wage inequality. As for the below-average earners, service workers and sales persons, elementary workers (physical labor workers), and clerks occupy the most disadvantageous positions in the labor market. We also see that in 2006, for the first time, the contribution of professional occupations to wage inequality exceeded that of business executive and managerial occupations, making professional occupations the largest contributors to wage inequality. This seems to confirm the supposition that an information economy leads to the declining importance of managers and to the increasing importance of professionals (Martin, 1998; Williams, 2007).



Source: The author's calculations based on GBAS data

Figure 24. Theil elements by occupation, 1987-2005

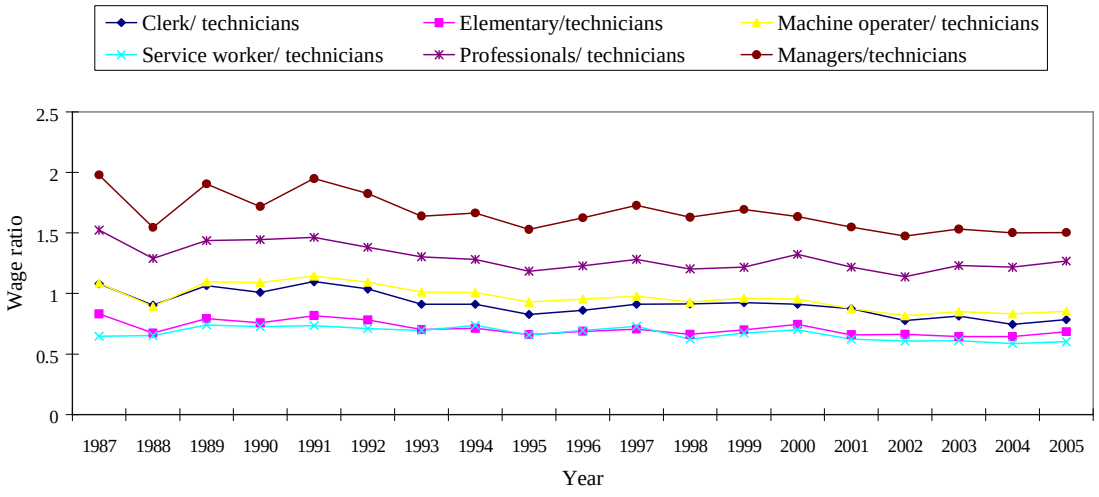
Figure 25 shows the ratio of blue to white-collar workers' average monthly wages. From the earliest data available (1989), there is a clear trend towards the uneven decline of this ratio, from around 0.979 in 1989 to 0.909 in 2005, with the lowest point in 2002, at 0.891. This means that as white-collar workers' wages have risen, blue-collar workers' wages have continued to fall. The decline of labor-intensive manufacturing and the surge of information-intensive industries are believed to have caused this trend because information-intensive industries hire fewer blue-collar workers. Other possible factors may include Taiwan's open immigration labor policies since 1991 and the relocation of labor-intensive sectors of information industries to mainland China since 1990. All three of these factors resulted in the wage improvement for workers with professional knowledge/skills (mainly white-collar), especially for computer professionals or financial workers, and the wage decrease for workers replaceable by Southeast Asian immigrants and mainland Chinese workers such as machine operators and elementary (physical labor) workers (mainly blue-collar).



Source: The author's calculations according to GBAS data

Figure 25. Monthly wage ratio, 1989-2005, blue-collar/white-collar workers

Figure 26 reveals the phenomenon of rising wages for professional, skilled workers. The figure displays wage ratios over time, comparing other occupations to technicians or associate professionals. As we can see in this figure, the ratio of the monthly wages of machine operators to the wages of technicians continually dropped from 1.09 in 1987 to 0.85 in 2005. The ratio of the monthly wages of elementary workers to the wages of technicians also fell from 0.83 to 0.68. Similarly, the ratios of monthly wages of clerks to the monthly wages of technicians and that of service workers to that of technicians decreased from .08 to 0.78 and from 0.65 to 0.60.

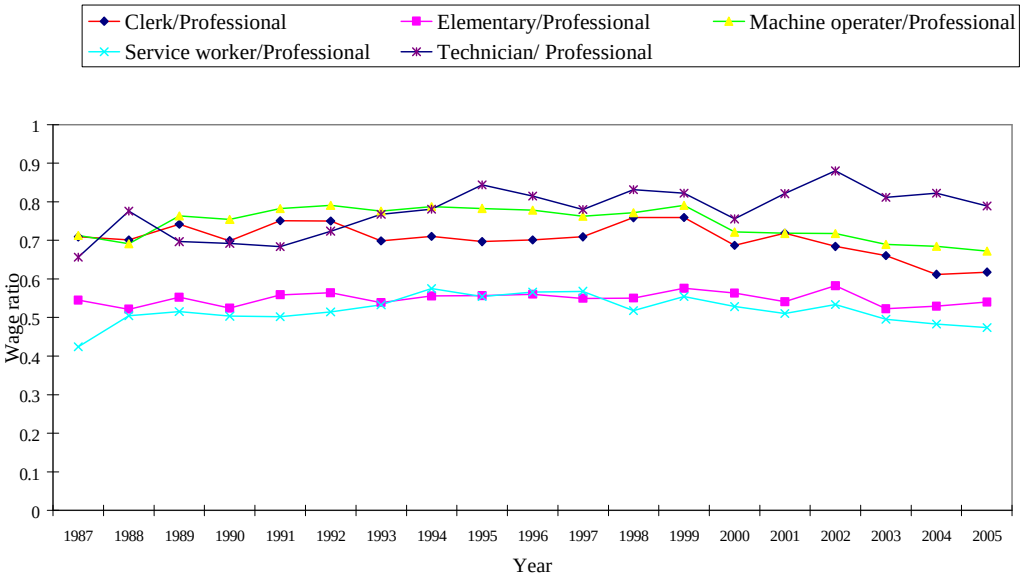


Source: The author's calculations based on GBAS data

Figure 26. Monthly wage ratio, 1987-2005, other occupations to technicians

Figure 27 offers a slightly different perspective, displaying a wage-ratio comparison of other occupations to professional positions, enabling us to further understand wage inequality in Taiwan. As we can see, the wage ratio of machine operators to professionals rose substantially at the end of the 1980s and peaked in 1992; but from 1992 on, it continued to decline from 0.79 to only 0.67 in 2005. The clerks-to-

professionals wage ratio fell gradually and unevenly, from 0.709 in 1987 to around 0.617 in 2005. The wage ratios of elementary workers to professionals reveal greater fluctuations, with change rates as wide as 6% in one year (such as 2001 to 2002, as well as 2002 to 2003), although from 1987 to 2005 the overall change was less than 0.5%, which seems to indicate no change. A wage comparison of service and sales workers to professionals reveals minor differences although service and sales workers' wages were the lowest on average among all of the occupation categories. The wage ratio reached its highest point in 1994, reaching 0.575 but then slowly declined to 0.473 in 2005.



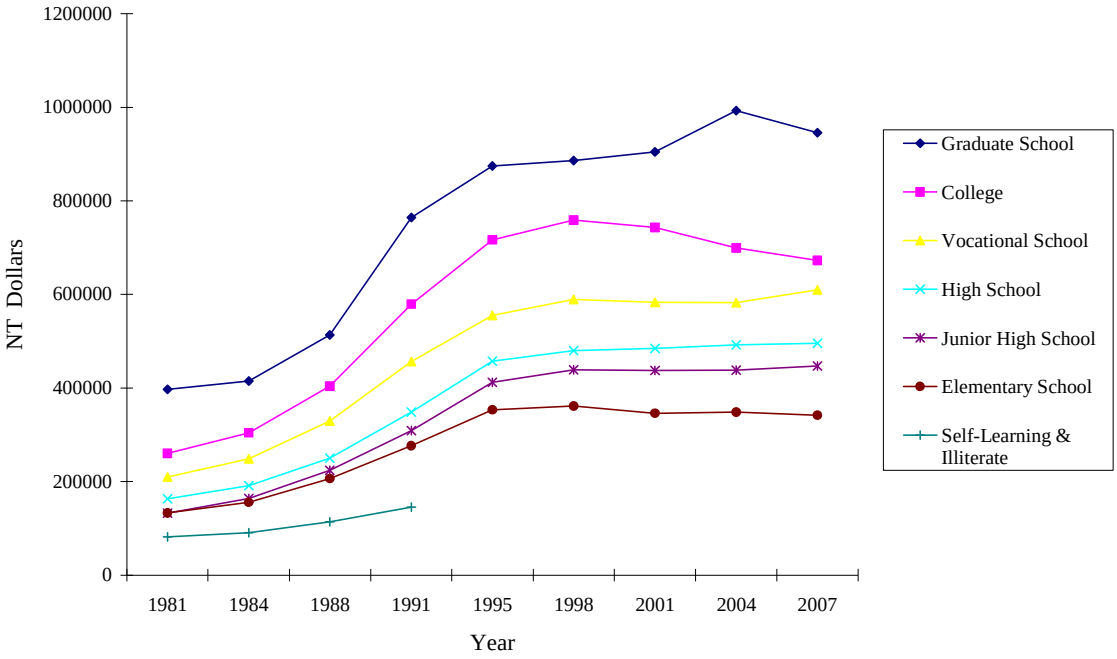
Source: The author's calculations based on GBAS data

Figure 27. Monthly wage ratio, 1987-2005, other occupations to professionals

Thus, for the wage disparities among occupations, based on the above wage ratio comparisons, we can observe an apparent wage loss for blue-collar workers and in occupations requiring lower professional and technical skills, compared to professional or semi-professional jobs. Although this shift is gradual rather than dramatic, it has increased Taiwan's economic inequality over the last two decades.

If we also consider education, as Figure 28 represents, we observe widening wage gaps between each group with varying levels of education after 1988. except for the gap between college graduates and vocational school graduates. There was first an increasing gap between college graduates and vocational school graduates, but then it dropped when the college graduates suffered from wage decline after 1998 due to over supply. The widening gaps are particularly apparent between workers with graduate school degrees and other degrees; the differences jumped in the late 1990s and also in the 2000s. For example, looking at the comparison between workers with a graduate degree and those with a college degree, it seems that the wage difference stayed comparatively stable in the 1980s, but in the early 1990s, wages increased for workers with graduate degrees. Between 2001 and 2007, the gap grew even larger due to a decline in wages for workers with a college degree. The average wage of college graduates continued to fall after 1998 as other groups of workers experienced a wage freeze due to Taiwan's economic recession. The only groups that still had a wage increase were workers with graduate degrees or vocational school degrees. Additionally, college graduates suffered from a large wage loss after 1995 and in the 2000s, due to the over supply of college graduates in the job market. During that time, the Taiwanese government adopted loose college entrance standards, allowing an increasing number of colleges to be created between 1995 and the early 2000s, in order to enhance the average education level of workers in Taiwan. This resulted in a flood of university graduates that lacked practical skills in the market, and their wages fell below the level of vocational school graduates. Nevertheless, with the exception of the college graduate group, workers with professional sk such as those with graduate and vocational school degrees enjoyed more wage superiority and increasing wages than other worker groups. The demand for technicians in the information industries provided vocational school graduates with opportunities to work in the IT industry, allowing them to use their professional and practical skills. As for other groups, the wage difference between high school and junior high graduates revealed little

change; otherwise, gaps between all of the other groups with different levels of education had significant increases (especially the gaps between the group of workers holding graduate degrees and other workers).



Source: GBAS data

Figure 28. Income by education, 1981-2007

In summary, after determining the trends in wage inequality in Taiwan for the last two decades by using the calculations of the Theil statistics presented in the last section, we then explored the loci of those increasing wage disparities from three perspectives—wage inequality among industries, among occupations, and among different education levels. The results show that, first of all, labor in the information-intensive industries did enjoy higher, increasing wages and also expanded the wage gaps between workers in these industries and other traditional labor-intensive industry workers; second, professional and semi-professional occupations benefited, especially compared to less professional and skilled occupations; finally, the wage gaps among different education

levels grew (showing an increasing tendency toward wage inequality due to education), with the group of graduate school graduates benefiting the most as they continued to receive higher wages than other groups of workers.

THE DETERMINANTS OF ECONOMIC INEQUALITY IN AN INFORMATION ECONOMY IN TAIWAN, 1990-2007: ESTIMATION AND RESULTS

As in the previous two chapters, the research is concerned with the relationship between informatization and inequality. The empirical analysis in this section will attempt to identify the relationship between income and wage inequality changes in Taiwan's transition to an information economy. We will also attempt to isolate the impact of informatization from the general trajectory of Taiwan's economy.

This discussion of economic inequality utilizes four variables to indicate the patterns of wage and income inequality in Taiwan: 1) the wage inequality index, or the Theil statistics; 2) the income inequality index known as the Gini coefficient; 3) the inequality index based on the ratio of income share of the highest 20% to that of the lowest 20%; and 4) the wage ratio between blue-collar and white-collar workers. As in the previous two chapters, I will define informatization as the extent of the informatization of the economy, measured by the percentage contribution of information-intensive industries to the total GDP; the informatization of production, measured by the extent of automation in the economy (the automation equipment density in businesses);[21] the informatization of production, measured by percentage of R & D in the total GDP; and information infrastructure and IT usage, quantified by calculating personal computers per 100 inhabitants, Internet users per 100 inhabitants, main telephone lines per 100 inhabitants, and mobile cellular phone subscribers per 100 inhabitants.

[21] Relevant indicators such as computer ownership and Internet use rates in Taiwan businesses are lacking.

Nevertheless, employment pattern changes could be an outcome of general economic trends in the economy as a whole; thus, we also need to control for Taiwan's gross domestic product in the current analysis.

Table 7. Correlations for informatization and economic inequality controlling for GDP, 1990-2007

	Wage inequality: Theil statistics	Income inequality: Gini Coefficient	Ratio of income share of highest 20% to that of lowest 20%	Blue/white wage ratio
Informatization of the economy	.897**	.995**	.987**	-.434
Percentage of R & D in the total GDP	.905*	.995**	.985**	.345
Automation equipment density	.956**	.982**	.985**	-.299
Personal computers per 100 inhabitants	.902**	.964**	.953**	.323
Internet users per 100 inhabitants	.961**	.982**	.973**	-.025
Main telephone lines per 100 inhabitants	.885**	.992**	.982**	.054
Mobile cellular telephone subscribers per 100 inhabitants	.876**	.923**	.918**	-.115
N	15	13	15	14

Note 1:Control variable: GDP
Note 2: ** denotes that the value is significant at the 0.01 level (2-tailed).

As we can see from Table 7, all the informatization indicators reach strong and statistical significance on the correlations with wage inequality. The greater the scope of informatization and economic informatization, the greater the extent of wage inequality.

Regarding the two income inequality indicators, the Gini coefficient and the ratio of income share of the highest 20% to that of the lowest 20%, all the informatization indicators are statistically significant and show a strong correlation with income inequality; the greater the extent of informatization, the greater the income inequality.

With regard to the last variable, the blue/white-collar worker wage ratio, none of the informatization indicators present statistically significant correlations.

In summary, the statistical results presented here demonstrate to some extent that the growing trend of economic inequality in Taiwan in recent years is closely related to the development of an information economy and the process of informatization. This finding is consistent with the observation made in other information countries that process of informatization and the development of an information economy might worsen economic inequality.

CONCLUSION

Several important trends have been indentified in this chapter. First, drawing from the calculation and observation of income and wage inequality indexes, Gini Coefficient, Percentage Share of Disposable Income by Percentile Group of Households (the ratio of income share of highest 20% to that of lowest 20%), and the Theil Statistics, Taiwan's income and wage inequality has continued to rise since 1980, after its historically lowest point in the 1970s. During this time, Taiwan has been confronting an industrial transition from labor-intensive manufacturing to information-intensive manufacturing and information-intensive services.

Second, based on the calculation and analysis of the Theil elements, this study found that the main sources of the increasing wage inequality are primarily information-intensive manufacturing and information-intensive service industries such as electronic

parts, computers, transportation & telecommunication, professional, science & technical services, medical services, and chemical materials.

Third, after identifying the sources of increasing wage inequality of Taiwan after 1980, the study further investigated the loci of this increasing wage inequality from three perspectives: the wage inequality among industries, among occupations, and among different educational levels. In comparing industries, it was discovered that labor in the information-intensive industries enjoyed higher, increasing wages and also expanded the wage gaps between workers in these industries and other traditional labor-intensive industry workers. On the occupational level, professional, semi-professional, and managerial occupations benefited the most from the wage trends, especially compared to less professional and skilled occupations, and were the main contributors to wage inequality among occupations. Finally, comparing groups with different levels of education, wage gaps among different education levels grew (showing an increasing tendency toward wage inequality due to education), with the group of graduate school degree holders benefiting the most as their wages rose the most in comparison to other groups.

The last section of this chapter examined the relationships of between informatization and four different kinds of income or wage inequality indicators: 1) the wage inequality index, or the Theil statistics; 2) the income inequality index known as the Gini coefficient; 3) the inequality index based on the ratio of income share of the highest 20% to that of the lowest 20%; and 4) the wage ratio between blue-collar and white-collar workers. The statistics results show that in Taiwan, the growing wage and income inequality is closely correlated to the process of informatization. Furthermore, the directions of correlation all conform to the researcher's expectation that when the extent of informatization increases, so does wage and income inequality

Overall, we can conclude that, like other information society countries, Taiwan underwent a growing economic inequality when developing its information economy and

informatization. The main cause of Taiwan's increasing wage inequality has been the rise of information intensive industries, and the specific sources of this increasing inequality are the enlarging wage gaps between information and traditional industries; between professional skilled workers and less professional, less skilled workers; and between workers with higher education and workers with less education. In addition, the statistical analysis supports the claim that informatization is closely related to the increased wage and income inequality.

Chapter 7: Conclusion

This research investigated the labor market changes that occur when an NIC such as Taiwan develops an information economy. This dissertation first traced the development of Taiwan's information economy and more importantly, the various social forces or factors that shaped this development. It then identified the changing trends of the labor market, incorporating trends of occupation transformation, unemployment, and wage disparity. Based on data for the labor market changes, this investigation traced the sources of these changes and, more significantly, the reasons for these changes, by employing statistical analyses. This chapter summarizes and interprets the main findings from the research and in the last section, offers a general conclusion and makes a number of policy suggestions for governments dealing with an emerging, unbalanced labor market in an information economy.

SOCIAL FORCES AND THE DEVELOPMENT OF TAIWAN'S INFORMATION ECONOMY

The dissertation points out the functions of various social forces in the development of Taiwan's information economy. In the first half of the early stage of Taiwan's information industry development (1954-1984), foreign capital played a crucial role, initiating the development of Taiwan's information industry. In the latter half, however, the government stepped in and led the development of Taiwan's information economy with numerous policy instruments including industrial policy (industrial development policy, industrial competition policy, industrial support policy, and industrial infrastructure policy), technology policy, exchange rates, interest rates, wage and labor policy, immigrant policy, and education and human capital policy. However, after the late 1980s, the government's power in controlling Taiwan's information economy development gradually waned and was replaced by the power of industry and enterprise, as the domination of the KMT party decreased in both politics and society,

alongside the growth in the social and economic influences of the commercial and industrial sectors. In addition to these three social forces, because Taiwan's IT industries have always highly relied on exports and international markets, the development of Taiwan's information economy was significantly impacted by international politics and economics, especially the trend of global outsourcing as well as by transnational IT name brands. Overall, it is evident that transnational capital, government/political leaders and policies, technological experts, the industrial elite and IT enterprises as well as international political economic factors, structure, and circumstance, all exerted crucial influences on the evolution of Taiwan's information economy. Compared to these forces, social forces such as labor unions had much less power in impacting the development of the information economy. And different from the information-economy development models of developed countries which most information society studies address, in the development of an information economy in an NIC such as Taiwan, the government, instead of market logic, played practically the most considerable role in shaping the developmental direction Taiwan would take to transform from labor-intensive manufacturing toward an information-intensive economy.

LABOR MARKET CHANGES IN AN INFORMATION ECONOMY, AND SOURCES AND REASONS FOR THESE CHANGES

The main goal of this dissertation was to investigate labor market changes and the reasons for these changes under the scenario of information-economy development. First of all, let us look at the related issues of occupation structure transformation.

The transformation of Taiwan's occupational structure

Previous research has identified several trends in occupation structure changes that are brought about in the transition to an information economy such as increasing professional and knowledge jobs and declining blue-collar and managerial jobs. In

Taiwan's case, the number of blue-collar workers did drop considerably compared to white-collar workers; second, professional occupations as a percentage of total employment did continually grow; and third, in contrast to the assertions of information society scholars, managerial jobs in Taiwan did not show an obvious drop-off.

Moreover, it is worth noting that the occupation that grows the quickest in Taiwan is that of semi-professionals, or technicians. This reveals that Taiwan's information economy is in fact on the semi-periphery of developed countries.

The correlation analysis shows that the advent of informatization did highly correlate to the decline of blue-collar jobs and the growth of professional occupations; this was inconsistent with the case of the literature review, where there is a declining trend in the number of middle level managers as the information economy develops.

Increasing unemployment

While considering the employment trend in an information economy, information society scholars have not yet reached any common conclusions on the relationship between information economy and employment. As is summarized in the literature review of this dissertation, four different viewpoints are proposed with respect to the employment issue in an information economy, including: enhanced employment, reduced employment, long-term balance, and varying according to different situations.

In Taiwan's case, the unemployment rate reached its lowest point in the 1970s, the end of the golden age of Taiwan's labor-intensive manufacturing and then began rising as the economy shifted toward information-intensive and information-technology production. However, the cause and effect of information economy on unemployment needed further empirical research. This study first tracked the sources contributing to the growing unemployment rate and an enlarging informal sector. It looked into the individual industries and determined that, compared to the increase in the total GDP

information-intensive manufacturing did not actually contribute as much to employment as it did to the total GDP. And it was common service industries and information-intensive industries that made up the employment loss when labor-intensive manufacturing waned.

The dissertation also compares the trends of GDP and employment contributions of labor-intensive manufacturing and information-intensive industry. The results indicate that the increase in the employment ratio of the information-intensive sector lags far behind the employment decline in labor intensive manufacturing. Furthermore, the percentage of employment contribution in the total employment of information intensive industry also lags far behind its contribution percentage in the total GDP, creating excessive industrial profits and causing general unemployment across the board.

Finally, the study employed statistical analyses to examine the relationships between informatization and unemployment. The correlation analyses show that informatization is highly and positively related to the unemployment patterns; the higher the extent of informatization, the greater the unemployment rate and also the larger the informal sector.

Thus, according to all these analyses, the research did reveal that the transition to an information economy actually increased Taiwan's unemployment problem and that the main basis for this worsening trend was the development of information-intensive industries. Unlike many developed countries that have already outsourced their information-intensive manufacturing, Taiwan still depends considerably on IT manufacturing industries for economic growth and employment. The extensive automation of production in IT industries and the immaturity of information-intensive services have caused the inability of information-intensive industries to absorb the superfluous labor released after the decline of labor-intensive industries, causing a continual worsening of Taiwan's unemployment problem.

Increasing wage disparity

Drawing from the literature, it seems that most scholars tend to agree that an information economy might exhibit a gradual movement toward greater wage or income disparity. However, scholars are far from reaching a consensus on whether the primary reason for this growing inequality is because of either the prevailing adoption of information technology (the skill-biased technological change), the increasing application of knowledge and information in the economy, a cultural spirit of informationalism, or political choices through policies and other long existing economic reasons. This dissertation reveals that along with Taiwan's economic transition from labor-intensive manufacturing to an information-intensive economy (starting in the 1980s), no matter which kind of wage and income inequality indexes are considered (Gini coefficient, the ratio of income share of highest 20% to that of lowest 20%, or Theil's Statistics), they all indicate an obvious trend of increasing wage or income inequality since the 1980s.

Further, based on the Theil's elements shown in the bar graphs, we find that the main sources of this increasing wage inequality are primarily information-intensive industries, including both information-intensive manufacturing (such as electronic parts and computers) and information-intensive services (such as telecommunication; professional, science and technical services; and medical services).

This dissertation further examines wage disparity by three perspectives--among industries, among occupations, and among different educational levels--and reveals that in all three cases, wage gaps did apparently grow with the onset of the information economy, and the primary beneficiaries include workers in information-intensive industries, workers who are professional, semi-professional, or higher managers, and workers who have graduate school degrees. This result seemingly verifies the argument that workers with more professional and higher level knowledge and workers who are

more closely related to the information economy and information technology do enjoy higher wages than other workers. However, these results simply show us the sources of wage disparity but do not explain why this trend developed.

This dissertation study applied statistical analysis to test the relationships of wage/income inequality to informatization. The correlation analyses show significant, strong, and positive correlations between the informatization indicators and the wage and income inequality indicators (the Theil's statistics, the Gini coefficient, and the ratio of income share of the highest 20% to that of the lowest 20%). The directions of the relationships between informatization and wage/income inequality conforms to the researcher's expectations that the greater the extent of informatization, the wider the wage/income inequality.

In summary, this dissertation identifies an increasing trend of wage and income inequality in Taiwan after 1980, and then verifies that one of the important sources of this enlarging inequality is the information intensive industry. Finally, the correlation analyses in this study show that informatization, especially economic informatization, highly correlates to increased wage and income inequality. The findings of these statistical analyses are striking since the majority of information society scholars tend to focus on the influence of information technology on economic inequality (such as skill biased technological change), and tend to ignore the function of government and its policies in these processes. These findings reveal that although information technology itself matters, economic and industrial transformation, which are highly influenced by states and their policies, also matter a great deal.

CONCLUSION AND POLICY SUGGESTIONS

Overall, in the past fifteen years, the labor market in Taiwan has seemingly moved toward a situation of unbalance and greater economic inequality in terms of wage,

unemployment, and occupation imbalance, when the economy began shifting from traditional labor-intensive manufacturing to information-intensive industries. This situation seemingly conforms to the observations of some information economy or political economy scholars describing the growth of economic informatization.

As for the development processes of information economy, Taiwan (an NIC), apparently also diverges from the experience of developed countries. As Katz (1988) pointed out, the evolution of developed countries' informatization and information economy was often based on market logic, yet the development of informatization in developing countries was very often led by political power for not only economic concerns but also sometimes for political or social purposes. This study determined that, foreign capital, the state, and the domestic capital were by turns the main actors during the different stages in the processes of Taiwan's (an NIC country) information economy development, while all these developments were conditioned by global political and economic situations and contexts. Among these factors, the state actually played the most critical function as it shaped the economic direction Taiwan would take to transform its economy from labor-intensive manufacturing toward an information-intensive economy. Furthermore, the state helped upgrade Taiwan's information industries from labor-intensive information industries such as IC packaging (the age dominated by foreign capital) to a real information economy, with more and higher-level production knowledge and high-tech information, which includes information intensive-manufacturing and information-intensive services. Even though, during the 1980s and 1990s, many aspects of society in Taiwan were becoming more liberal and global and the KMT state's autonomy in formulating and executing economic policy was undercut, the state consistently acted relatively autonomously from the capitalist class and from the influence of globalization.

This study also reveals that the total labor demand of information-manufacturing and information-intensive services is much less than that of traditional labor-intensive manufacturing, resulting in Taiwan's increasing unemployment problem.

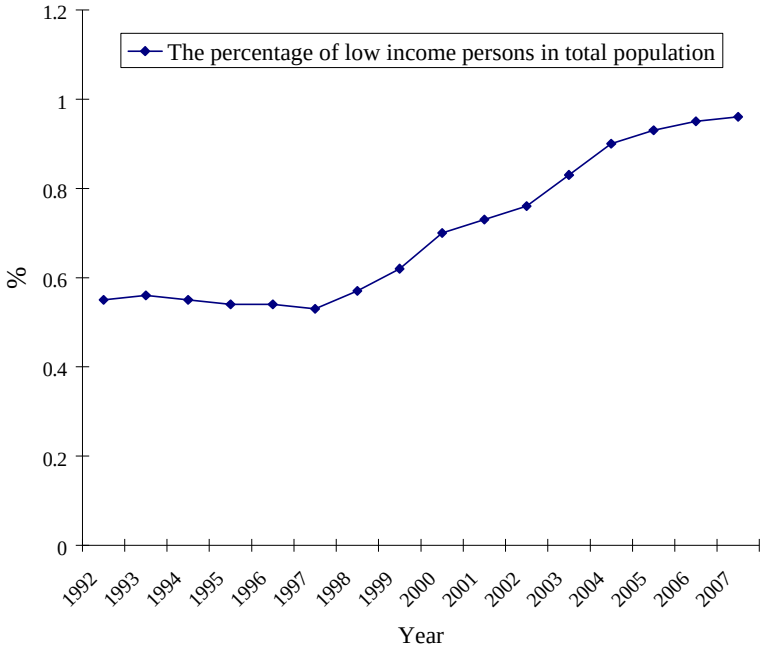
Combining the results of all the historical, policy, and statistical analyses, this dissertation concludes that the transformation from labor-intensive manufacturing to an information-intensive economy, as arranged by the Taiwanese government due to its own political, governing, and economic purposes, and also in the context of international political and economic circumstances, has determined Taiwan's economic resource arrangement, which has resulted in an increasingly unbalanced labor market in terms of wage distribution, unemployment, and occupation structure. This transformation changed and shaped the structure of the labor market to benefit workers who are more skilled with information and more professional, having higher level knowledge and a higher level of education, while an increasing amount of white-collar and service workers began earning comparatively low wages. At the same time, the demand for blue-collar and lower skill workers severely declined. Moreover, the total labor demand of information-manufacturing and information-intensive services is much less than that of traditional labor-intensive manufacturing, resulting in Taiwan's increasing unemployment problem. In a nutshell, the unbalanced arrangement of economic resources led by the Taiwanese government on only a number of strategic information industries--which resulted in the unbalanced employment selectively affecting certain positions for certain industries, which further led to unemployment and structural unemployment, and finally caused an unbalanced labor market and also a bias wage structure--is the reality of Taiwan's information economy. Among these processes, many different social, political, policy, and economic factors interacted and collectively determined this result. Among them, the role of the state in shaping Taiwan's information economy in general and the labor market situation in particular did matter considerably. This viewpoint reminds us to be cautious of technological determinism or similar viewpoints often seen in information

society studies. Such views point toward skill-biased technological change and information determinism or informationalism, which asserts information technology and information's determining power. Advancing beyond these deterministic approaches, we should emphasize the importance of the long existing political economic factors such as the state's political choices and policies, industrial transformation, and certainly also globalization, international trade, and international political economic structure, circumstance, and operation. This dissertation proposes that these are among the most important factors shaping an NIC's, in this caseTaiwan's, information economy and thus influencing its labor market situation over the last two decades.

Despite some negative impacts on the labor market, we cannot conclude that the economic transition in Taiwan should be regretted. In the view of the government and domestic capitalists, under the pressure of rising labor and production costs and rigorous competition from the low-priced labor and production factors of other developing countries, Taiwan had no choice but to relinquish traditional manufacturing industries in order to upgrade to a higher level of economic production. However, concerns about economic development balance, labor market balance, full employment, and economic fairness are just as important as considering how to seek quantitative economic growth, especially when the unbalanced labor market and the unfair economic result is partially caused by the government's economic development and industrial policies, when the government should also support the well-being of its citizens. More importantly, failing to acknowledge all of these concerns could lead to serious consequences such as nation-wide poverty, which would in turn threaten economic development and also a society's stability.

As Figure 29 shows, Taiwan's poverty rate shows a growth trend in the last decade, from 0.53% in 1997, to 0.73% in 2001, to 0.96% in 2007. This study calculated the correlation (r) between poverty and wage inequality (Gini Coefficient), unemployment, and occupational transformation, and the results are 0.865, 0.799, and -

0.878, all significant at the 0.01 level (2-tailed), revealing a high correlation of wage inequality, unemployment, and occupation transformation with Taiwan's poverty rate in the last fifteen years. Thus, the negative effects of economy informatization on the labor market and society should not be overlooked by the government as it will not only negatively affect people's well-being but also threaten the sustained growth of the economy and consumer market.



Source: The department of Statistics, Ministry of the Interior, R. O. C.

Figure 29. The trend of poverty in Taiwan

In light of the importance of government policy for impacting the labor market, this chapter offers some possible relevant policy orientations, drawing from other countries' experiences and also from Taiwan's specific condition as policy suggestions.

Let us first consider policy from a macro-economic perspective. The macro-economic policies or means are believed more direct and effective in easing labor market

inequality. Most importantly, as Galbraith's suggested (2002), the government should not give up the goal of pursuing sustained full employment, as unemployment is highly related to wage inequality as well. Ways to create more jobs and new promising industries in Taiwan are discussed later in this chapter. Other helpful means include enhancing social insurance, creating reasonable price stability, providing a collective bargaining device[22], avoiding sharp recession-induced inequality, collecting reasonable progressive taxes, raising minimum wages, and maintaining a proper exchange rate, as well as stable interest rates. And for Taiwan in particular, the government should take labor market balance into consideration when making industrial and other related policies. These actions are all believed to be beneficial in alleviating the labor market imbalance problem (Cornia, 2000; Fishlow & Parker, 1999; Galbraith, 2000b, 2002).

Second we can consider the micro or individual worker perspective, also known as the labor-market level. The main idea here is for the government to help the labor market make a smooth transition when the economy and industrial structure shift. In addition, maintaining inexpensive tuition for university education helps to restrain growing economic inequality. Additional initiatives might include tuition assistance for the unemployed workers' advanced education and school-to-work programs, clear information for job training programs, a database for job matching linked to resources such as education and training opportunities, job placement, childcare, portable health insurance, and saturation policies that target poor communities to promote investment in housing, businesses, schools, training, and job creation in order to reduce social and economic isolation. Moreover, unemployment assistance can be combined with needed job training (Black & Lynch, 2003; Freeman, 1999; Lynch, 1999; Steelman & Weinberg, 2005).

[22] Collective bargaining devices that can be applied to the whole society would be very helpful as in industries such as the service industry where the worker amount is sometimes not big enough to establish a labor union (Galbraith, 2002).

For Taiwan specifically, the government should take into account the problem of the unbalanced labor market when promoting industrial policies; that is to say, when choosing strategic industries, the government should be concerned not only with economic growth rate and trading surplus but also with the balance of employment. Thus, the government ought not to prefer only information-intensive industries, which mainly contribute to professional and white-collar workers' employment; rather, other promising industries that can contribute to blue-collar and lower income workers' employment should also be considered. These industries in today's Taiwan might include medical care and elder care industries, tourism industries, urban renewal, community work for deprived and disadvantage communities, local cultural industries, resource recycling industries, innovative traditional manufacturing industries with higher added values (such as high-tech textile or organic food industries) and finally, new agriculture industry. Moreover, policy and financial support for small and medium-sized enterprises should also be encouraged since small and medium enterprises also contribute to a more balanced employment and also to a more equal labor wage structure.

Here I want to specifically address the new agriculture and innovative traditional manufacturing industries. In Taiwan, the agriculture industry has encountered serious decline in the last fifty years not only because Taiwan's natural environment limits her comparative advantage in agricultural production but also because of the Taiwanese government's suppression and purposeful ignorance in policy. In order to withdraw capital, labor, and land from agricultural industries and transfer it to manufacturing, the government adopted numerous policies that were believed to strike agricultural and village areas severely. However, the agriculture industry is very important to economic stability, especially in a recession or when demand for labor undergoes considerable change. Under such circumstances, the agricultural industry often becomes a shelter for the unemployed, especially for blue-collar workers, as we see in Taiwan's situation. Though it may at first seem unwise to promote agriculture in an information age, the

results of this research indicate otherwise. Compared to other Asian countries, Taiwan still has advanced techniques and excellent experts in agriculture R & D, and Taiwan also offers a unique environment for planting and developing new, unique and high quality agricultural products. Thus, developing a precise, innovative, and information-intensive agriculture industry is one possible way to promote cooperation between professional experts and blue-collar workers, easing the blue-collar workers' unemployment problem while also helping to solve Taiwan's serious environmental pollution crisis.

To help traditional labor-intensive manufacturing upgrade to innovative and new manufacturing with more intensive knowledge and information, the government ought to change the imbalance of education resources which focus only on information technology and information service. Similar supportive policies could be used to encourage the development of new manufacturing in order to sustain more blue-collar worker employment.

It seems that a more diverse industrial policy and a more balanced labor market would not only reduce the risk of economic strikes such as the worldwide IT industrial recession of 2001-2003 but could also address the need to take care of the society at all different economic levels and including many different kinds of labor. In addition, considering the experience of the U.S. in pursuing an information economy/ new economy by placing excessive importance on finance, banking, insurance, lawsuits, R & D, and service industries while ignoring manufacturing, which has resulted in the recent economic crisis, this report proposes that manufacturing, agriculture, the production of actual materials or construction, the diversity of industries, and a balanced labor market are very crucial to an economy's health and stability. Unbalanced stress on an information or knowledge-production economy has been verified as problematic.

Finally, the Taiwan government ought to consider the unfairness of the present education system. Most education resources are given to high and middle-class family

students through subsidizing public universities[23], which further increases the inequality of the future labor market. Moreover, the government should encourage and support efforts by domestic universities to produce research of the same high caliber as other developed countries, especially fundamental scientific research and also should be more open to hiring professors and researchers from other countries to diversify Taiwan's university research, raising it to an international level.

Building on this research, a number of country-comparison research studies might be needed to further verify the actual influence of economic informatization on labor markets, ruling out impacts derived from different historical, political, and economic backgrounds.

Moreover, the influence of the rise of mainland China's economy should also be further considered in the future. As the dissertation pointed out in previous chapters, the moving of Taiwan's labor-intensive industries to mainland China sped up and worsened the unbalanced situation of Taiwan's labor market which demanded less blue-collar workers during its information economy growth. In recent years, companies and factories that moved to China have not been limited to only labor-intensive industries but also to information-intensive industries. Thus, will this become a new challenge to Taiwan's economy and also to its labor market? Can Taiwan keep pursuing further industrial upgrades to maintain the competitive advantage in information economy and information technology production? Or will Taiwan finally lose the competitive edge and face a new, severe unemployment problem because of the hollow of the industries? This question is intriguing and deserving of further research.

All in all, it is hoped that it is hoped that this dissertation has helped shed light on some critical aspects of the relationships between labor market changes in an information economy and other social, political, and economic factors and that additional research

[23] In Taiwan, the public universities are higher academically than private ones, just opposite to the U.S.

will be conducted in the future that will aid workers who have been disenfranchised by Taiwan's information economy.

Appendix

THE THEIL STATISTICS

This dissertation presents the calculation of a single annual index of inequality in the wage structure using the lower-bound, between-group estimate of Theil's T statistics (T´) because the required data for calculating within-group inequality—the individual wage data—were usually not available. For a group structure, this dissertation uses wage and employment data from the main employment sectors in Taiwan. The main sectors this paper analyzes include manufacturing industries such as: mining and quarrying, electricity, gas and water, construction, trade, transportation and telecommunication, finance and insurance, real estate, rental and leasing, accommodation and food services, professional, science and technical services, health care, cultural, sporting and recreational services, as well as additional services. Agricultural sectors are not included since they are part of an unofficial employment sector in Taiwan and do not have wage and employment data available. The raw data come from measures and survey data gathered by the Taiwanese government, mainly from the Directorate-General of Budget, Accounting, and Statistics, Executive Yuan, Republic of China (the DGBAS). The group-wise decomposability of Theil's statistic measure of inequality permits us to use these data to compute an estimate of the evolving inequality in the wage structure over time. It produces a measure of changing relative wage dispersion that is weighted by the relative size of the working population in each of the underlying classes of economic activity (Berner & Galbraith, 2001; Conceição & Ferreira, 2000; Ferguson & Galbraith, 2001).

The formula of Theil' s statistics of income inequality is included below, which is composed of between-group inequality (T ´) plus within-group inequality (T_w) (Conceição & Galbraith, 2001, pp. 264-267). If we consider that the population is divided

into m industry groups, $g_1, g_2, \ldots g_m$, each with n_j individuals, $j = 1,\ldots, m$, then the decomposition takes the self-similar form of a fractal:

$$\begin{cases} T = \sum_{j=1}^{m} pjRj \log Rj + \sum_{j=1}^{m} pjRjTj \\ T_j = \frac{1}{nj} \sum_{i \in gj} ri \log ri \end{cases} \quad (1)$$

The employment proportion in each group is represented by $p_j = \frac{n_j}{n}$. The ratio of average group income to overall average income is represented by $R_j = \frac{\mu_j}{\mu}$. The ratio between individual income (y_i) and average income (μ_Y) is represented by γ_i. In this equation, n represents employment, μ represents average income, and j represents a subscript denoting the group.

The lower-bound, between-group estimate of Theil's T statistics, T´ formula is as follows:

$$T' = \sum_{j=1}^{m} p_j R_j \log R_j \quad (2)$$

OPERATIONALIZATION, MEASURE, AND VARIABLES

The labor market variables

A. Occupation transformation in an information economy

To detect occupation transformation in an information economy, I will adopt three indicators based on the literature review: blue-collar to white-collar employment ratio, the percentage change of professional occupations in total employment, and the managers to other occupation employment ratio. According to the literature, during a transformation to an information economy, there will be less blue-collar workers than white-collar workers, more professional employment and less managers since computers will replace managers.

B. Employment trends in information economy

I will use two indicators to identify employment trends in an information economy: the unemployment rate and the scope of informal sector. Unemployment rate, according to the Directorate-General of Budget, Accounting, and Statistics, R.O.C., refers to the percentage of unemployed in the entire labor force. The entire labor force refers to people who are over 15 years old and have capacity to work. The unemployed refer to people who: (1) have no work; (2) can work right away; and (3) are now looking for a job. Moreover, people who have found jobs but are waiting to start working are also included in the unemployed group.

As for the informal sector, according to the DGBAS, is the percentage of people who are older than 15 years old but not working nor looking for a job for other reasons in the entire labor force. The entire labor force refers to people who are over 15 years old and have the capacity to work.

The unemployment rate and the scope of the informal sector can provide a helpful understanding of employment trends in an information society since the informal sector includes people who are unemployed long-term and thus have lost the capacity to work or look for a job.

C. Economy inequality in an information economy

Here I will adopt three different indicators/variables: the wage inequality indicator—the Theil's statistics; the household income inequality indicator—Gini coefficient; the ratio of household income share of highest 20% to that of lowest 20%; and the blue-collar to white-collar wage ratio to represent and incorporate the idea of economic inequality in an information economy. The first two indicators are the most widely used indicators to measure wage inequality and household income inequality. The third indicator—the blue collar to white collar wage ratio—would keep enlarging the wage disparity between blue-collar and white-collar works in an information economy, based on the literature review.

Informatization variables

The informatization variables are based on the literature, Taiwan's specific situations, as well as the availability of data.

- Informatization of the economy: The information economy percentage measured by the percentage contribution of information-intensive industries to the total GDP.
- Percentage of R&D in GDP: The percentage of investment for research and development in the total GDP.
- Automation Equipment Density: The total investment in automation equipment divided by the number of workers.
- Personal computers per 100 inhabitants: The number of personal computers per 100 inhabitants.
- Internet users per 100 inhabitants: The Internet users per 100 inhabitants.
- Main telephone line per 100 inhabitants: The main (fixed) telephone line per 100 inhabitants.
- Mobile cellular telephone subscribers per 100 inhabitants: The mobile cellular subscriber per 100 inhabitants.

Definitions and data sources of all variables

Table 8. Definitions and data sources of all variables

Wage Inequality of the Theil statistics:	Between group Theil statistic computed for wage inequality between major sectors; data source: the author's calculation based on the DGBAS data.
Income Inequality of Gini Coefficient	The Gini Coefficient index for each year; data sources: the DGBAS data.
The ratio of household income share of highest 20% to that of lowest 20%:	The ratio of household income share of highest 20% to that of lowest 20%: data sources: the DGBAS data.
The blue collar to white collar wage ratio	The blue-collar to white-collar wage ratio: data sources: the author's calculation based on the DGBAS data.
Unemployment	Unemployment rate; data source: the DGBAS data.
Informal Sector	The percentage of informal labor in the total labor force.
Blue / White Collar Employment	The ratio of blue-collar to white-collar worker employment; data source: the author's calculation based on the DGBAS data.
Professional Employment	The percentage of professional employment (professional, associate professional, technician, business executives & managers) in the total GDP; data source: the author's calculation based on the DGBAS data.
Manager employment	The ratio of manager employment to other occupations; data source: the author's calculation based on the DGBAS data.
Informatization of the economy	The percentage contribution of information intensive industries to the total GDP; data source: data from Wang (2008).
Percentage of R&D in GDP	The percentage of investment for research and development in the total GDP; data source: National Science Council, R.O.C.
Automation Equipment Density	The total investment in automation equipment divided by the number of workers: data source: the Department of Statistics, Ministry of Economic Affairs, R.O.C.
Personal computers per 100 inhabitants	The number of computers per 100 inhabitants; data source: ITU database 2007.
Internet users per 100 inhabitants	The Internet users per 100 inhabitants; data source: ITU database 2007.
Main telephone line per 100 inhabitants	The main (fixed) telephone line per 100 inhabitants: ITU database 2007.
Mobile cellular telephone subscribers per 100 inhabitants	The mobile cellular subscriber per 100 inhabitants: ITU database 2007.
The GDP	The GDP per year: data source: the DGBAS data.

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